ACRP

REPORT 34

AIRPORT COOPERATIVE RESEARCH PROGRAM

Sponsored by the Federal Aviation Administration

Handbook to Assess the Impacts of Constrained Parking at Airports

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Handbook to Assess the Impacts of Constrained Parking at Airports

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), and the Air Transport Association (ATA) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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The research team would also like to thank the staff members of those airports that participated in this research: Bob Hope Airport, Boston Logan International Airport, Chicago O'Hare International Airport, Huntsville International Airport, McCarran International Airport, Miami International Airport, Oakland International Airport, Port Columbus International Airport, Portland International Airport, San Antonio International Airport, San Diego International Airport, Seattle-Tacoma International Airport, Tampa International Airport, Tulsa International Airport, and Washington Dulles International Airport.

FOREWORD

By Marci A. Greenberger
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ACRP Report 34: Handbook to Assess the Impacts of Constrained Parking at Airports discusses the different types of parking constraints that airports experience, provides tools to assess the impacts of the constraints and strategies to deal with them, and provides a predictive modeling tool (included herein as *CRP-CD-80: Parking Forecast Model and Instructions for Use: Supplemental Materials for ACRP Report 34*). The modeling tool will assist in determining the effects of implementing various strategies. The report considers two types of customers when addressing parking strategy: (1) the flying public and the mode of transportation in getting to/from the airport and (2) employees. Financial, traffic and congestion, emissions, and customer service impacts will vary by strategy as well as by circumstance at an individual airport and the customer base served at that airport. The handbook and modeling tool will be useful to airport executives, planners, CFOs, and metropolitan planning organizations in determining solutions to parking constraints. In addition, airport executives can read the Executive Summary (available on our website) for a brief overview of the handbook.

Parking accounts for a significant portion of non-airline airport revenues. It is not just the public who need parking options, but airport employees require a significant number of spaces, often at fees and rates below market value; however, accommodating airport employees is vital to airport operations and airport tenants. Airports can also have parking constraints due to policy decisions. For example, decisions to reduce the number of single-occupancy trips may have an effect on airport parking that needs to be examined. Airports need to better understand how to assess and evaluate how strategies to deal with parking constraints or to alter demand will impact their financial plans, vehicle traffic and congestion, and emissions.

Under ACRP Project 10-06, Ricondo and Associates, Inc., in conjunction with DMR Consulting and Resources Systems Group, Inc., developed *ACRP Report 34: Handbook to Assess the Impacts of Constrained Parking at Airports* by conducting case studies of airports that have experienced constrained parking conditions and by evaluating the cause and effect of the various factors that influence demand. The researchers also conducted passenger surveys to quantify passengers' current airport access behavior and their likely behavioral changes in response to potential future changes in the factors that affect demand for airport parking. The analysis of these surveys contributed to the predictive modeling tool that airport operators and other planning agencies will find helpful as they evaluate potential parking strategies.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

Handbook to Assess the Impacts of Constrained Parking at Airports

The intent of *ACRP Report 34: Handbook to Assess the Impacts of Constrained Parking at Airports* is to assist airport operators and others (such as external policymakers, metropolitan planning organizations, and those working on issues related to constrained airport parking) in assessing the impacts of constrained public and employee parking at airports.

At most airports, the provision of on-site parking—particularly if the parking supply is constrained or is anticipated to become constrained—is a high-profile and sometimes politically charged subject for several reasons, including the following:

- Revenues generated from public parking are a major source of funding at most airports and are often the highest nonaeronautical revenue source available to airport operators in support of ongoing airport operations and capital investments.
- A constrained parking supply can add stress to the airline passengers' airport experience. Airline passengers may view parking difficulties, such as searching for an available space or being redirected to a different parking facility, as an obstacle to boarding their flights and some time-constrained airline passengers may be concerned about missing their flights.
- The airport parking supply is used by a large percentage of airline passengers and airport employees, even when viable high-occupancy vehicle (HOV) modes serve the airport.
- Vehicle trips generated by airline passengers accessing the airport and associated vehicle emissions are often a focus in areas where traffic congestion and air quality are local concerns. Constrained parking conditions can exacerbate these problems related to airport-generated vehicle trips.

Constrained airport parking is a complex issue. The nature of the constraints varies from airport to airport. The operating environment, customer base, and goals and objectives for an airport parking system (i.e., the context in which constrained parking and its solutions are evaluated) vary from airport to airport. Consequently, the effectiveness of strategies implemented to manage or resolve constrained parking and the effects of implementing those strategies are unique to each airport. Strategy implementation may result in impacts on the financial resources of the airport enterprise; trips generated by airline passengers and the effects of those airport access and egress trips on the airport, local, and regional roadway systems; emissions generated from airport access and egress trips; and the parking customer's perception of level of service.

The Handbook

This Handbook is intended to serve as a planning resource for airport operators and others involved in assessing the impacts and understanding the effects of potential strategies for addressing constrained airport parking. The Handbook includes a description of the types

and causes of constrained airport parking, strategies to address constrained airport parking, tools and methodologies to predict the outcome of strategies being considered to manage the effects of constrained airport parking, an approach for selecting the appropriate strategies for the airport of concern, and ways to measure the results of strategies implemented.

For airports where constrained parking exists or is anticipated, the Handbook is intended to facilitate an understanding, anticipation, and evaluation of changes in airport parking strategies to address constrained parking conditions.

The Handbook is designed to be informational and practical. The format is flexible so that users of the Handbook with varying levels of experience with constrained parking can draw on specific chapters of the Handbook to meet immediate needs or work through the Handbook from beginning to end to comprehensively address a current or anticipated constrained parking situation.

This research project was guided by an ACRP project panel of airport professionals with a thorough understanding of the topic. The panelists played an active role in the research and development of the Handbook. The underlying research for the Handbook included information gathered from staff at 15 U.S. airports (*1–15*) and subsequent analysis of data from a subset of these airports, as well as development and testing of a predictive tool for estimating the effects of implementing various strategies to resolve constrained parking conditions.

All 15 airports whose representatives participated in this research experienced parking constraints at some point in the 10-year period between 1998 and 2008, and they were selected to represent a cross-section of characteristics of U.S. airports in relation to public parking (see Table S-1). The research for this project was conducted in 2008 and 2009, a period of declining airline passenger activity resulting from a global economic downturn. Thus, most airports were not experiencing ongoing constrained parking conditions at the time of this research, but staff were able to draw on historical experience and data to provide perspective to the research team, as well as to present information on strategies implemented to address constrained airport parking in the past.

The predictive tool for estimating the effects of adopting a variety of parking strategies to resolve constrained public parking was developed using stated preference survey data collected by the research team at 14 of the 15 airports. The purpose of the stated preference survey was to develop an understanding of airline passenger choices related to constrained airport parking and to provide insight into ways to predict airline passenger mode choice behavior in response to implementing those strategies being considered to alleviate constrained parking. The predictive tool, a Microsoft Excel–based forecast model, allows users to test different outcomes based on airline passenger behavior when faced with choices such as increased parking prices and transit options with varying levels of service and cost. The predictive tool is available on the CD-ROM that accompanies this report.

Overview of Effects of Constrained Parking at Airports

The research team investigated several key issues regarding the relationship between constrained public parking and airline passenger mode choice behavior. The value of the predictive tool developed for this research project in evaluating strategies being considered to address constrained parking also was assessed. The main findings of the research conducted under ACRP Project 10-06 are as follows:

Constrained public parking conditions at airports lead to increased use of passenger pickup and drop-off modes at a higher rate than to increased use of HOV modes. This mode shift, from an airline passenger driving to the airport and parking a private automobile for the duration of the trip (i.e., two ground access trips) to an airline passenger being dropped off and picked up at the airport by a friend or relative (i.e., four ground access trips), not only results in increased curbside congestion, but also in increased vehicle trips to and from the airport, increased regional roadway congestion, and increased vehicle emissions. This under-

Table S-1. Characteristics of the 15 airports participating in ACRP Project 10-06 research.

Airport	Hub Classification[1]	Policy or Public Sentiment Influences Decisions Related to Parking Supply	Within a Competing Airport System	Privately Operated Off-Airport Parking Available	HOV Mode Share	
					Scheduled HOV Modes[2]	All HOV Modes[3]
Boston Logan International (BOS)	Large	✓	✓	✓	14%	24%
Chicago O'Hare International (ORD)	Large		✓	✓	13%	13%
McCarran International (LAS)	Large				–	20%
Miami International (MIA)	Large		✓	✓	1%	8%
San Diego International (SAN)	Large	✓		✓	1%	12%
Seattle-Tacoma International (SEA)	Large	✓		✓	2%	19%
Tampa International (TPA)	Large			✓	–	4%
Washington Dulles International (IAD)	Large		✓		1%	5%
Bob Hope (BUR)	Medium	✓	✓	✓	1%	5%
Oakland International (OAK)	Medium		✓	✓	12%	15%
Port Columbus International (CMH)	Medium		✓	✓	–[4]	7%
Portland International (PDX)	Medium	✓		✓	7%	10%
San Antonio International (SAT)	Medium		✓	✓	–	–
Huntsville International (HSV)	Small		✓	✓	–	–
Tulsa International (TUL)	Small		✓	✓	–	–

Notes:

HOV means high-occupancy vehicle.

– Data are not available or not applicable.

[1] Hub size is defined by the FAA for commercial service airports based on the community's share of total U.S. passenger boardings accommodated. Large-hub airports accommodate 1% or more of annual passenger boardings; medium-hub airports accommodate at least 0.25%, but less than 1% of passenger boardings; and small-hub airports accommodate at least 0.05%, but less than 0.25% of passenger boardings in the United States and its territorial possessions.

[2] Scheduled HOV modes include public transportation plus privately operated buses and vans that run on a fixed schedule.

[3] All HOV modes include shared-ride vans and charter vehicles, in addition to the scheduled HOV modes listed above. Courtesy shuttles are not included.

[4] At CMH, scheduled HOVs are included with other categories, so the scheduled HOV mode share is unknown.

Source: Airports Council International–North America, *Airport Traffic Reports*, "2007 Final Traffic Count," accessed November 2008 (hub classifications—total passengers); FAA, *Airport Hub Classifications*, November 2008 (hub classifications); DMR Consulting and Ricondo & Associates, Inc., based on interviews with airport representatives conducted between November 2008 and February 2009 (*1–15*) (airport characteristics other than hub classifications).

standing of mode shifts is critical when policymakers evaluate the advantages and disadvantages of policy-driven airport parking constraints.

Constrained parking at one airport in a competing system of airports is not a significant factor influencing airline passengers' choice of competing airports. Airline passengers in metropolitan areas served by multiple airports that offer commercial airline service tend to consider other airports when planning their trips; however, the cost of the flight and minimizing the travel time of the airline trip were the most important considerations influencing airline passenger choice of airports. The availability of parking at any of the competing airports in the system was not a significant determinant of airline passenger choice of airports.

A constrained parking forecast model developed based on data from a stated preference survey can be a valuable prediction tool for airport operators to use in developing an understanding of airline passenger behavior resulting from implementation of a strategy to address constrained airport parking. This research project included development of a general airport parking forecast model that can be downloaded from the TRB website and used by U.S. airport operators and others to test policy considerations related to constrained parking at a planning level. To use the model, analysts must either have mode-share distribution information for the airport or have a general understanding of the mode-share distribution at the airport under consideration. The value of the stated preference survey and constrained parking forecast model has been demonstrated through this research project. These tools were proven to be valid and useful, and can be developed for a specific airport environment by adopting the methodology recommended in the Final Report for ACRP Project 10-06, which includes recommended refinements to the stated preference survey and is available on the TRB website.

Although airport operators implement a wide range of strategies to manage constrained parking, they typically rely on a general sense of the effectiveness of the strategies rather than formal analysis to measure and quantify the results. Furthermore, airport operators typically do not collect and retain the full scope of data needed to effectively quantify the outcomes of the strategies implemented. To quantify whether the implemented strategies achieved airport management's desired objective, data characterizing the parking conditions must be collected and maintained both before and after the strategy is implemented. The decision to collect data to support an understanding of the effects of specific strategies implemented involves examining the tradeoff between the time and cost of data collection and the usefulness or benefit of the information to be obtained.

Most airport operators tend to believe that employee parking constraints are easier to solve than public parking constraints. Typically, airport employees drive to the airport in single-occupant vehicles, and airport operators tend to find solutions to accommodate the demand for employee parking rather than to influence employee commute behavior for several reasons: (1) peaks in airport employee parking demand are easier to accommodate because they are more predictable and less pronounced than peaks in public parking demand, (2) airport operators typically have more flexibility in locating areas to accommodate employee parking as opposed to public parking, (3) public transit service schedules may not accommodate employee work shift schedules and thus may not be a viable option for many employees, and (4) airport operators may be obligated to provide parking for airport tenant employees under use and lease agreements with those tenants. Although many airport operators offer programs or incentives to encourage their own employees to share rides or use transit, a collective effort among the airport operator and airport tenant employers may be necessary to significantly reduce the demand for employee parking at an airport or to reduce the number of employee commute trips to and from the airport.

How to Use the Handbook

The Handbook is structured to address the steps an airport operator would take to fully assess the effects of constrained parking, as well as to determine the effectiveness and effects of strategies considered to manage or resolve constrained parking as follows:

1. Predict when upcoming constraints may occur,
2. Identify a menu of strategies to resolve constraints and their potential outcomes,
3. Select strategies to manage or resolve the constrained parking situation—identify potentially viable strategies and predict their potential outcomes, and
4. Evaluate the effectiveness of strategies adopted to manage or resolve the constrained parking situation.

It is anticipated that the needs of the users of this Handbook will vary—some users may desire a quick solution to an infrequent constrained parking event, while other users may be considering long-lasting strategies that require capital investment or executive or regulatory approval. The Handbook, therefore, is structured so that users can reference specific topics as needed, or follow the Handbook from beginning to end to fully assess the constrained parking situation and the options available to manage or resolve the constraints.

Chapters 1 through 3 of the Handbook provide a general understanding of the airport parking environment, the constrained airport parking environment, and the value of a clearly defined set of goals and objectives in selecting strategies to alleviate the constrained parking condition. Users of the Handbook should review these chapters because they define the terminology and establish a common framework for interpreting the guidance provided in the following chapters.

Chapters 4 through 8 of the Handbook lead the user through the steps necessary to anticipate a constrained public parking situation, identify strategies to address constrained public parking appropriate to the airport environment, and evaluate the effectiveness of those strategies, both before and after implementation.

Chapter 9 covers issues related to constrained employee parking conditions at airports. Compared to public parking, airport operators tend to collect less data on constrained employee parking, expend fewer resources to track trends, and explore and implement fewer strategies to address employee parking constraints other than increasing supply; thus, information on constrained employee parking is covered in one chapter that discusses the employee commute environment, provides an overview of strategies an airport operator can consider to address constrained employee parking (such as influencing employee commute behavior), and provides guidance on how to evaluate the effectiveness of implemented strategies.

The Handbook also provides information on, and instructions for the use of, the predictive general airport constrained parking forecast model. This model can be downloaded from the TRB website and used by U.S. airport operators and others to test policy considerations related to constrained public parking at a planning level.

Each airport operator faces a unique set of challenges related to constrained parking and the potential strategies that may be considered to alleviate the constraint. It is useful, however, to understand how operators of other airports have handled similar challenges and whether or not they were successful. Therefore, to illustrate specific experiences, this Handbook includes case studies, which were primarily developed from those airports participating in this research project. The information provided in the case studies is based on the conditions at those airports at the time the airport representatives were interviewed (late 2008 through early 2009). Specific interview dates are identified in the references section of the Handbook. An airplane symbol (similar to the one at the right) is used to denote an applicable case study in the Handbook.

Finally, a glossary of terms is provided at the end of the Handbook to serve as a reference for users of the Handbook. The majority of these terms are defined in Chapters 1 and 2.

The Handbook is structured to facilitate an airport operator's ability to select strategies to alleviate parking constraints based on the individual needs of that airport operator. Figure S-1 illustrates the main functional components of the Handbook and presents a diagram of the relationships among and between the components and individual Handbook chapters. Figure S-1 also presents a series of questions that a user of the Handbook may have that can guide the user to the relevant chapters of the Handbook.

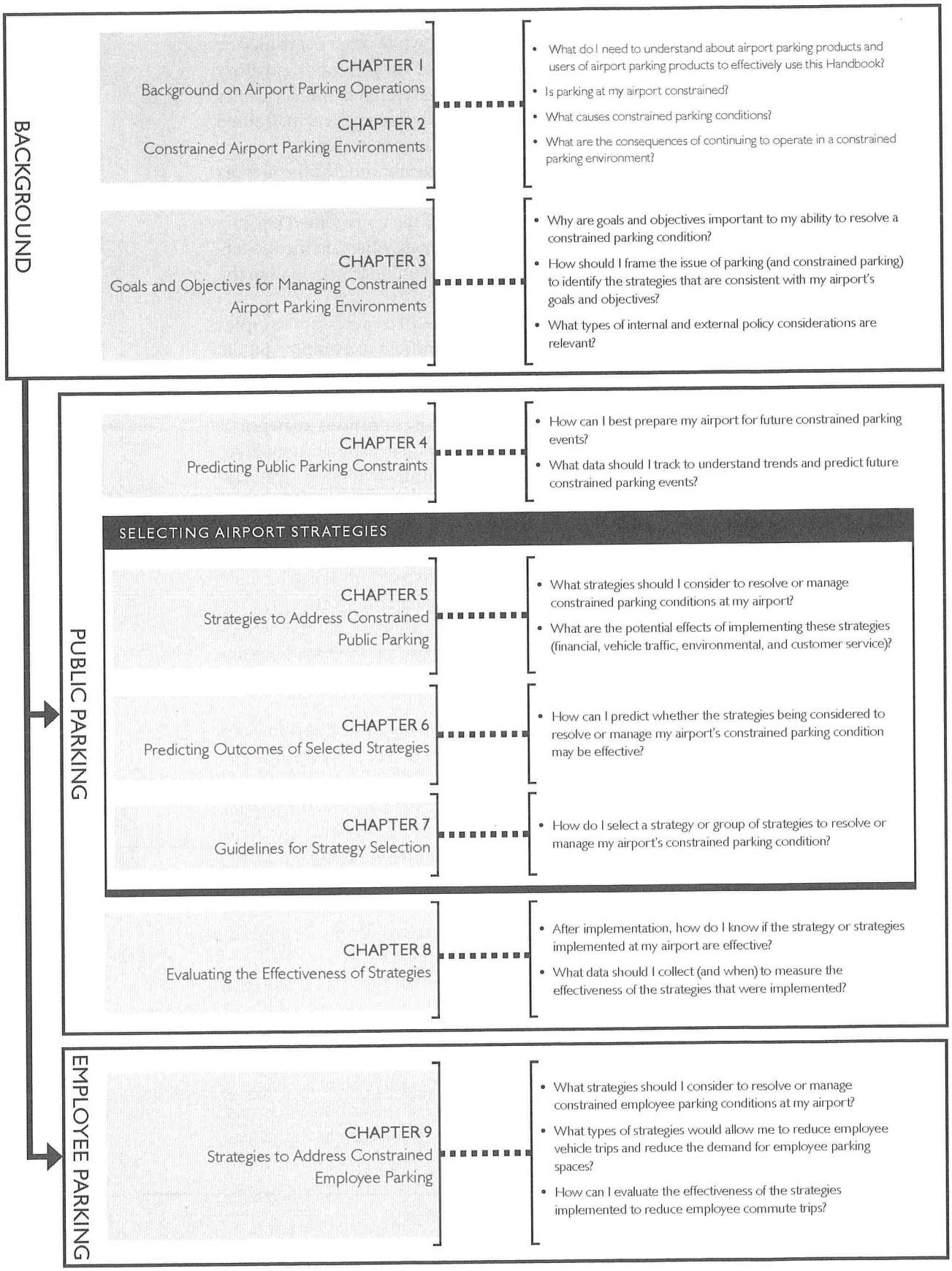


Figure S-1. Guide to contents and structure of the handbook.

CHAPTER 1

Background on Airport Parking Operations

This chapter provides essential background information on parking operations at commercial service airports in the United States. Airport parking in the context of an airport's ground access environment is discussed and typical airport parking products commonly offered by airport operators are described. The customer segments and how the characteristics of an airline passenger's trip influence ground access mode choice, including parking preferences, are also described.

Parking as Part of the Airport Ground Access Environment

A variety of ground transportation modes are available for airline passengers to travel to and from an airport via the local and regional surface transportation network. Generally speaking, fewer modes of access are available to airport employees traveling to and from work than are available for airline passengers. Typical ground transportation modes for airline passengers and airport employees are discussed in the rest of this section.

Airline Passengers

The relationship between the availability of parking and an airline passenger's use of ground access modes is addressed in this Handbook. Although the range of airport access modes available to airline passengers varies by airport, general similarities among airports can be noted. Table 1 provides a range of ground access mode options that are typically available to airline passengers.

An airline passenger party is one that travels together to an airport to take the same flight (the same is true upon the party's return). The single-party access modes—private automobile, rental car, taxicab, and limousine—serve one airline passenger party traveling together to or from the airport, provide a door-to-door travel experience for the airline passenger party, and are available for travel to or from an airport according to the airline passenger's schedule (i.e., on demand). HOV modes—shared-ride van, other van, bus, subway, light rail, commuter rail, and Amtrak—serve multiple airline passenger parties and may operate on a fixed schedule, or the trip departure time is set based on the travel needs of all customers being served on the trip. Airline passengers using scheduled service modes must adjust their departure and arrival times for the access and egress trip according to the service schedule.

The public parking supply at an airport accommodates the following general types of parkers:

- **Long-term parkers**—For the purposes of this Handbook, long-term parkers are defined as those airline passengers who park an automobile at an airport for the duration of their trips, regardless of duration. This term applies to airline passengers whose round-trip flights depart and return on the same day, or that return after multiple days or weeks. In general, long-term parkers consist of two subgroups—the business day-tripper who parks for less than 24 hours and the airline passenger who parks for multiple days, including both the business and nonbusiness airline passenger. Even though some long-term parkers depart from, and return to, the airport on the same day, parking durations of less than 8 h for this purpose are possible, but rare. Long-term parkers may use any of the parking products offered at an airport, as described in this chapter. Choices of products and facilities are typically based on cost, proximity or travel time to the terminal, the availability of parking, customer service and amenities, and perceived safety.
- **Short-term parkers**—For the purposes of this Handbook, short-term parkers are defined as any customers in the airport public parking system that are not airline passengers, and that typically park for less than 6 h. Examples of short-term parkers include greeters and well-wishers (i.e., persons picking up or dropping off an airline passenger party), persons that come to the airport for business purposes who are not taking a flight, those who visit the airport for recreational

Table 1. Generic airport ground access modes.

Airline Passenger Parties Served	Mode	Nature of Service
Single Party	Private Automobile Pickup and Drop-Off and Use of Curbside Only	On Demand
	Private Automobile Pickup and Drop-Off and Use of Parking by Greeter or Well-Wisher	On Demand
	Private Automobile Parked for Duration of Airline Trip	On Demand
	Rental Car	On Demand
	Taxicab	On Demand
	Limousine	On Demand
Multiple Parties	Shared-Ride Van	On Demand, Door-to-Door Service
	Bus or Van—Transit or Privately Operated	Scheduled Service
	Subway, Light Rail, Commuter Rail, or Amtrak	Scheduled Service

Source: DMR Consulting and Ricondo & Associates, Inc., November 2009.

purposes (e.g., airfield observation), and the occasional airport employee who is willing to pay commercial parking rates to park close to the terminal rather than in an employee parking facility. Short-term parkers, including greeters and well-wishers who park rather than pick up or drop-off passengers at the curbside, will most likely park in the facility that offers a short walk to the terminal area, if space is available.

Airport Employees

For the purposes of this research project, airport employees are defined as employees of the airport operator, airline tenants, other airport tenants, or other aviation-related businesses located on airport property. Typically, airport employees commute to the airport via private automobile or public transportation, if available. Employees use the parking supply for the duration of their work assignment. Employee parking is used in one of the following ways:

- For the duration of an employee work day, which is typically less than 12 h; or
- For the duration of airline flight crew members' work assignment, which may be for multiple days.

Parking Products

A menu of generic airline passenger and employee parking products that may be offered at an airport is shown in Table 2 and discussed in this section. The selection of products offered, naming conventions used, general characteristics, and classifications of the parking products vary by airport. The characteristics shown in Table 2 for each general parking product type help define the typical range of airport parking products offered.

- **Airport operator or private operator**—Each parking product is noted as being airport operated, meaning that it is operated by the airport operator (or a contracted parking management company on behalf of the airport operator), or privately operated, meaning that a private operator provides parking in the vicinity of the airport but typically not on airport property.
- **Facility location relative to terminal building**—Parking products can be characterized based on the general location of each parking facility relative to the terminal(s). For the purposes of this Handbook, parking products are classified as terminal area parking and remote parking. Terminal area parking consists of parking products that are typically located within walking distance of the terminal building. The range of parking products includes facilities located directly adjacent to the terminal(s) that offer the shortest and most convenient walk to the terminal(s), as well as parking facilities that are located an "intermediate" distance from the terminal building that may be walkable, but that may also be served by a shuttle bus or other means of transportation (e.g., automated people mover [APM], moving sidewalks). Remote parking products are located at greater distances from the terminal(s), requiring a shuttle bus or other means of conveyance to transport parkers between the parking facility and the terminal(s). Remote locations can include public parking operated by the airport operator as well as privately operated parking facilities located off airport property.
- **Parking customer served**—As noted earlier, airport parkers typically choose the facility in which they park based on considerations such as how long they will need to park at the airport, the cost of parking, services offered in each facility, and safety, among others. Short-term parking is typically used by customers who desire the greatest convenience, while long-term parkers tend to balance conven-

Table 2. Generic airport parking products and characteristics.

Parking Facility	Parking Operator		Location		Parking Customer Served			Transportation Required
	Airport Operator	Private Operator	Terminal Area	Remote	Airline Passengers	Greeters and Well-Wishers	Employees	
Short-Term or Hourly	✓		✓		✓	✓	✓[1]	
Long-Term or Daily	✓		✓		✓	✓	✓[1]	✓[2]
Economy	✓			✓	✓		✓[1]	✓
Privately Operated		✓		✓	✓			✓
Valet	✓	✓[3]	✓	✓[3, 4]	✓			
Premium	✓	✓[3]	✓	✓[3]	✓			
Cell Phone Lot	✓			✓		✓		
Dedicated Employee	✓		✓	✓			✓	✓[2]
Employee Worksite	✓[5]						✓	

Notes:

[1] Employees are accommodated in public parking facilities at some airports.

[2] Shuttle service or another form of conveyance may be required to transport airline passengers between parking and the terminal or to transport employees between parking and the worksite, depending on the distance.

[3] Valet or premium parking products may be offered by a private off-airport parking provider. In these cases, the service would be offered in a remote location away from the terminal and would require parking customers to be transported between the facility and the terminal curbside.

[4] A remote valet product is a variation of the traditional valet product.

[5] Worksite parking may be operated under a lease to a tenant or tenants by the airport operator.

Source: Ricondo & Associates, Inc., and DMR Consulting, October 2009.

ience versus the cost of parking. Employees are typically assigned to a facility based on their work location at the airport (e.g., terminal area, service areas, cargo facilities).

- **Transportation requirements**—Table 2 notes if customers of the parking product would require a shuttle bus system or other form of conveyance to be transported between the parking facility and the airport destination.

Public Parking Products

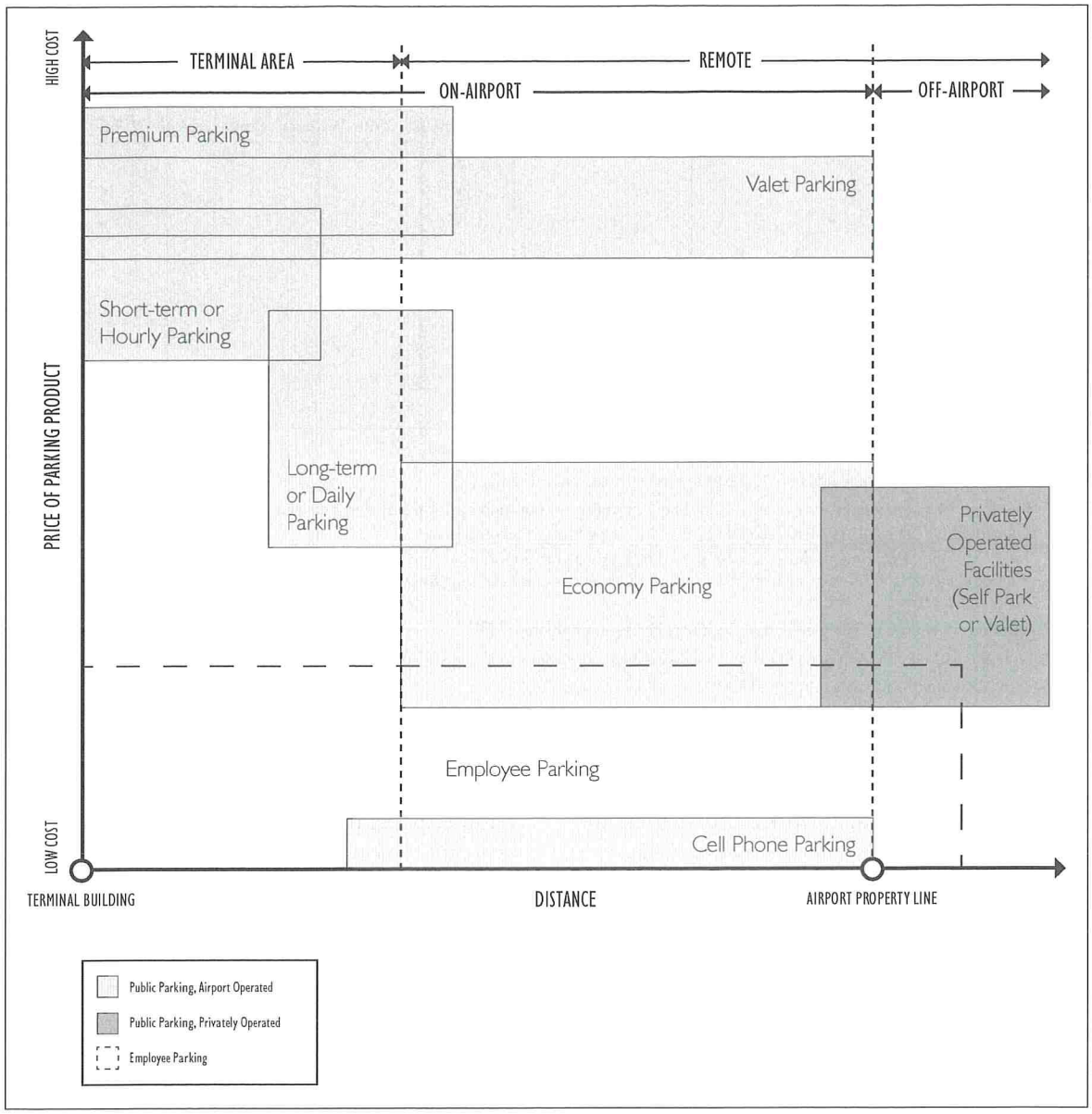
The airline passenger is typically offered a selection of public parking products that vary in price according to the level of service offered by the product. The characteristics that affect pricing typically include proximity to the terminal(s) and the services provided (e.g., valet parking, fixed-route shuttle buses, bumper-to-door shuttle service, reserved parking spaces, covered parking spaces, level of security). Although all of these factors affect the desirability of a parking product, the primary factor affecting the desirability and resultant price of the product is the location of the parking facility relative to the terminal(s). Those parking facilities located in close proximity to the terminal building are typically the most desired and command a higher parking rate. However, the practical application of this concept varies by airport.

As discussed previously, public parking products at airports are classified as either terminal area parking or remote parking. However, in many cases, the definition can not be applied strictly to a parking product given that many parking facilities "straddle the line" between close-in terminal area spaces and remote spaces that require a shuttle bus ride. Figure 1 illustrates the typical parking products offered at airports, their relative locations with respect to each other and the terminal building, and the relative cost to the user. It should be noted that there are exceptions to this model. In this example, the parking products are characterized as being terminal area parking, remote "on-airport" parking, and remote "off-airport" parking. The typical public parking products for accommodating airline passengers and airport employees within this general framework are summarized in this section.

Terminal Area Parking

The terminal area parking supply is typically adjacent to or within walking distance of the terminal building. The following parking products form a subset of the parking options commonly offered by airport operators in the terminal area:

- **Short-term parking,** sometimes referred to as "hourly parking," is typically the most convenient parking option for walking to the terminal(s). This parking product is intended to serve essentially all short-term parkers at the airport. In addition, short-term parking facilities typically serve some portion of long-term parkers who are willing to pay a higher fee for the convenience offered by this product (i.e., proximity to the terminal[s] relative to other parking products). As shown in Figure 1, short-term parking is typically offered at



Source: Ricondo & Associates, Inc., November 2009.

Figure 1. Relative location and price of airport parking products.

the highest daily rate, with the potential exception of valet parking and other premium parking options.

- **Long-term parking,** sometimes referred to as "daily parking," is a convenient option intended for long-term parkers. Generally, this product is provided within the terminal area, but farther from the terminal(s) than the short-term or hourly parking product. These facilities are usually located within a feasible walking distance to the terminal building; however, at some airports, long-term or daily parking facilities may also be served by shuttle buses or other mechanical means of transport (e.g., moving sidewalks with covered walkways). These parking products are typically offered at a lower daily cost compared with short-term parking and are, therefore, intended to provide a more economical yet convenient option for airline passengers parking for the duration of their trips.
- **Valet parking** is intended to provide a convenient option for airline passengers interested in parking their automobiles at a location adjacent to the terminal that does not require searching for a space. The valet stand is typically located at the terminal curbside or another area that offers the parking customer an easy walk to the terminal building. The valet operator may park the automobile in the immediate area or drive the automobile to a remote parking location. Typically, valet parking is used by long-term parkers and, to a lesser degree, by short-term parkers. A variation of the valet park-

Examples of Premium Parking Products: Boston Logan, Seattle-Tacoma, and Tulsa International Airports

Premium parking programs at Boston Logan, Seattle-Tacoma, and Tulsa International Airports provide guaranteed spaces for program participants, all with different program details.

PASSport Gold at Boston Logan International Airport is a premium-parking program that guarantees customers parking spaces in designated areas in the terminal area garages. In exchange for a guaranteed parking space, passengers pay a one-time enrollment fee, an annual fee, and a 21% premium over the daily rate in the terminal area. (*1*)

The Passport Parking Program at Seattle-Tacoma International Airport is designed for frequent business travelers and offers guaranteed parking for members. The passes are sold for a monthly fee, which is equivalent to paying for 14 days of parking at the daily rate for terminal area parking. This translates to a discounted daily rate of up to 55% if the pass is used every day. The pass is transferable among employees of a company, offering unlimited parking for one automobile at a time. (*6*)

The VIP Monthly Parking Program at Tulsa International Airport offers some dedicated parking in the rental car ready/return area adjacent to the terminal. It offers guaranteed parking to customers who pay a monthly fee equivalent to the fee for parking for 30 days in the long-term parking facility adjacent to the terminal. (*15*)

ing operation described, which is almost as convenient to the customer, can be provided from a valet stand positioned remotely from the terminal building. With this remote operation, the valet attendant rides in the private automobile with the customer to the terminal curbside, takes possession of the car from the customer at the curbside, and then drives and parks the automobile at the valet storage facility.

- **Premium parking** is intended to provide a higher level of service to a specific group of customers willing to pay a higher price for the convenience offered by the premium product. An airport operator may offer different types of premium parking products. The products may be designed to guarantee scarce spaces for time-sensitive customers, provide the most convenient spaces for these customers, or both. These premium services are typically provided to generate extra revenue for the airport, address an emerging customer need, and compete with privately operated off-airport lots, among other reasons. A range of pricing structures can be used, including offering the product to the general public at a higher daily rate than the "nonpremium" products offered at the airport, or offering a subscription service where parking customers (or their employers) are charged a one-time or recurring (monthly or annual) membership fee, in addition to (or in place of) an hourly or daily rate.

Remote Parking

Remote or "satellite" parking is typically located farther from the terminal(s) than terminal area parking, and walking between the parking area and the terminal building is typically not feasible (e.g., distance, walk time, or physical separation from the terminal area due to walls or roadways). The following subset of remote parking products may be offered at an airport:

- **Economy parking** is offered at a lower daily rate compared with the more convenient terminal area parking options. The economy parking supply is intended to provide the most economical option for long-term parkers. Since this supply is located at a relatively far distance from the terminal building, a shuttle bus or other form of conveyance is required to transport customers between the parking facility and the terminal(s). Airline passengers parking in this type of facility may choose to drop off the other members of their travel party and baggage at the terminal before parking. Because of the extra time involved in traveling to the terminal compared with close-in parking options, this product is not desirable for short-term parkers. As shown on Figure 1, economy parking is generally the least expensive and least convenient on-airport parking option offered by the airport operator.
- **Privately operated off-airport parking facilities** are operated by private entities and may or may not be considered as competition to the on-airport public parking supply managed by the airport operator. These facilities are typically located off-airport and a shuttle bus is required to transport customers between the parking facility and the terminal area; however, certain airport operators have developed business arrangements with private companies to operate

privately branded parking products on airport property. Value-added services offered by private parking operators vary, but may include valet parking, premium parking, pricing promotions, frequent parker discounts, and automobile detailing or servicing. Airline passengers parking in this type of facility may drop off the other members of their travel party and baggage at the terminal area before parking. Because of the need to travel in a shuttle bus and the time involved to travel to the terminal(s) compared with terminal area parking, this product is not desirable for short-term parkers.

- **Cell phone lots** may be provided as a parking area for greeters to park, free of charge, while they are waiting to pick up arriving airline passengers. Cell phone lots are typically located outside of the terminal area, but within easy access of the airport roadway and curbside system. The airline passenger calls the driver when he or she is ready to be picked up, and the driver meets the passenger at the terminal curbside. Some lots contain a flight information display system (FIDS) to inform drivers of the status of arriving flights. A cell phone lot primarily serves to relieve terminal curbside congestion by effectively reducing the associated dwell times of vehicles stopped at the curbside and by reducing the volume of recirculating private automobile trips on terminal area roadways.

Employee Parking Products

For purposes of this research project, airport employees are defined as employees of the airport operator, airline tenants, other airport tenants, or other aviation-related businesses located on airport property. The following employee parking products may be offered by the airport operator:

- **Dedicated employee parking** may be provided within the terminal area or remote from the terminal, and it may accommodate employees of a single employer, employees of multiple employers, or employees working in a particular location of the airport.
- **Employee parking in public parking facilities** may be offered at an airport. Within a public parking facility, an area may be dedicated for employee use, or employees may park in any space that is available to airline passengers.
- **Employee worksite parking** may be offered at various facilities around an airport. This type of parking may be provided in lots adjacent to the worksite, such as cargo buildings, aircraft maintenance hangars, rental car lots, flight kitchens, airport maintenance areas, or central utility plants.

Airport Parking Areas Not Covered in This Handbook

Airport operators often provide areas on airport property to accommodate parking for purposes other than public or employee parking. These uses are not considered part of the public or employee parking supply, although they may occasionally be accommodated within facilities that also accommodate public or employee parking. Other airport parking areas may include parking for rental car staging or storage, parking for airport service vehicles, and holding areas for commercial vehicles.

Understanding Customer Segments

The characteristics and needs of airport parking customers are important considerations in the operation and management of airport parking and familiarity with these characteristics and needs is important to understanding, resolving, or preventing constrained parking conditions. The airline passenger and employee customer segments that patronize airport parking facilities are described in this section. Chapter 8 of this Handbook discusses methods to obtain customer segment data at an airport.

Airline Passengers

Airline passengers at an airport are classified as being either origin and destination (O&D) passengers or connecting passengers. O&D passengers board a flight at the local airport to begin their airline travel or arrive at the local airport as the ending point to their airline travel, whereas connecting passengers only use the airport to connect to another flight. O&D passengers use some form of ground transportation to travel between the airport and the surrounding geographic catchment area, and connecting passengers do not. Therefore, parking and other ground transportation options accommodate O&D passengers only. Table 3 shows the relationship between total passenger activity and O&D passenger activity at the 15 representative airports participating in this research project. The significance of considering O&D data is demonstrated by comparing total enplaned passengers and enplaned O&D passengers at Washington Dulles (IAD) and Portland (PDX) International Airports. In 2007, about 67% more total enplaned passengers were processed at IAD than at PDX, yet about the same number of O&D passengers was processed at both airports.

The following two characteristics of the O&D airline passenger population influence the amount and type of parking required at an airport:

- Resident versus nonresident share of airport O&D passengers and
- Purpose of the airline passenger's trip.

An understanding of the characteristics of resident business and resident nonbusiness travelers will assist the users of this Handbook in determining the most appropriate strategies to implement, remedy, or prevent constrained airport parking

Table 3. O&D passenger activity at representative airports.

Airport	2007 Total Enplaned Passengers (millions)	O&D Percentage	2007 Enplaned O&D Passengers (millions)
Large Hub			
Boston Logan International (BOS)	28.10	90%	25.29
Chicago O'Hare International (ORD)	76.18	44%	33.28
McCarran International (LAS)	46.96	87%	40.86
Miami International (MIA)	33.81	41%	13.80
San Diego International (SAN)	18.34	96%	17.60
Seattle-Tacoma International (SEA)	31.30	75%	23.47
Tampa International (TPA)	19.20	90%	17.20
Washington Dulles International (IAD)	24.53	52%	12.79
Medium Hub			
Bob Hope (BUR)	5.92	99%	5.86
Oakland International (OAK)	14.61	95%	13.94
Port Columbus International (CMH)	7.73	95%	7.34
Portland International (PDX)	14.65	85%	12.45
San Antonio International (SAT)	8.03	91%	7.31
Small Hub			
Huntsville International (HSV)	1.24	94%	1.17
Tulsa International (TUL)	3.22	95%–99%	3.12

Source: Ricondo & Associates, Inc., and DMR Consulting, based on airport case studies prepared for ACRP Project 10-06. (*1–15*)

based on the needs of the airline passengers using the airport's parking products. The characteristics of resident business and resident nonbusiness travelers vary from airport to airport; therefore, it is important for the airport operator to understand the characteristics of its airline passenger market segmentation.

Resident Status

Airline passengers who reside in an airport's catchment area are referred to as resident airline passengers. Nonresident airline passengers are visiting the region in which the airport is located.

The significance of the resident segmentation as it relates to the airport parking supply is that spaces occupied by automobiles parked for the duration of the airline passengers' trips (long-term parkers) are used almost exclusively by resident airline passengers, as automobiles owned by nonresidents would be located in the catchment areas of their home airports. Public parking spaces occupied for short durations are often used by greeters and well-wishers visiting the airport to pick up and drop off resident or nonresident airline passengers, people doing business at the airport, and those who visit the airport for retail and shopping purposes.

Table 4 presents the shares of resident airline passengers at McCarran International Airport (LAS) and IAD. The difference in the shares of resident airline passengers between the two airports underscores the importance of collecting these data. Although LAS served more than three times as many O&D passengers as IAD in 2007, IAD served approximately 50% more resident airline passengers. Therefore, as evidenced by the data in Table 4, it is important to understand the O&D market share that influences the parking supply on an airport-by-airport basis.

Trip Purpose

The purpose of the airline passenger's trip influences the decision whether to patronize airport parking and which parking product to select. There are many reasons for taking an airline trip. However, to gain an understanding of ground access mode choice behavior, two primary trip purpose categories influence passenger behavior—whether the airline passenger is traveling for business or nonbusiness purposes. The reasons and circumstances for traveling are unique to each individual, but general key comparisons of business versus nonbusiness travel include the following:

- The business traveler takes more flights per year than the nonbusiness traveler.
- The business traveler's trip is subsidized by the traveler's employer; therefore, the business traveler will likely be more sensitive to travel time to and from the airport and less concerned about the cost of travel to and from the airport than the nonbusiness traveler.

Table 4. Comparison of resident airline passengers at Las Vegas McCarran and Washington Dulles International Airports.

Passenger Activity Component	McCarran International (LAS)	Washington Dulles International (IAD)
2007 Enplaned Passengers	46.96 million	24.53 million
2007 O&D Passenger Share	87%	52%
2007 Enplaned O&D Passengers	40.86 million	12.79 million
Resident O&D Passenger Share	15%	72%
2007 Resident O&D Enplaned Passengers	6.13 million	9.21 million
Hourly (Short-Term) Parking Supply (Spaces)	900[a]	1,920
Daily (Long-Term) Parking Supply (Spaces)	11,500[a]	21,550

Note:

[a] Estimated because the hourly and long-term parking split for 270 spaces at Terminal 2 was not available.

Source: Ricondo & Associates, Inc. and DMR Consulting, based on airport case studies conducted for ACRP Project 10-06. (*3, 8*)

- The average duration of a business trip is shorter than a nonbusiness trip. For example, business travelers often travel to a meeting and return home the same day. As such, business travelers, as compared with nonbusiness travelers, typically account for a higher proportion of airline trips with shorter durations.

Airport Employees

The number of employees at an airport and their commute patterns are the primary determinants for sizing the employee parking supply and, therefore, provide insight into employee parking constraints. Most medium- and large-hub airports operate on a 24-h per day schedule, 365 days per year, and are staffed accordingly. For purposes of this research project, airport employees are defined as employees of the airport operator, airline tenants, other airport tenants, or other aviation-related businesses located on airport property. The airport operator's direct influence over employee parking behavior or access mode choice may extend to only a small percentage of the total airport employee population because employees of the airport operator typically account for less than 10% of the total airport employee population. Table 5 shows the proportion of employees of the airport operator in relation to the total airport employee population for the 15 representative airports participating in this research project.

The following employee segments have distinct commuting characteristics:

- **Airline flight crews**—Work schedules for airline flight crew members (referred to as "tours of duty") often involve multiple-day trips. The flight crew member with a multiple-day tour of duty typically commutes to the airport by private automobile, occupies a parking space for more than one day (similar to an airline passenger), but tends to work fewer days per month compared to other airport employees. Consideration of this employee segment is important in understanding the turnover in parking spaces used and the resulting effect on constrained parking.
- **Shift workers**—The various airport employers who employ shift workers include the airport operator, airlines, rental car companies, airport concessionaires, cargo companies, TSA, and others. Consideration of this employee segment is important in the context of constrained parking because work shifts must overlap to service airport functions. Therefore, there typically is a higher demand for parking at shift changes than at other times; however, shifts are not necessarily consistent among airport employers.
- **Administrative employees**—Various airport employers maintain administrative staff at the airport, such as the airport operator, airlines, and other airport tenants. Consideration of this employee segment is important in the context of constrained parking because administrative employees may have more flexible work hours than shift workers or may be provided special parking privileges as an employment benefit. Also, the number and proportion of administrative employees can influence the degree to which employee parking space demand surges during shift changes.

Additional employment characteristics that influence the demand for parking include full-time and part-time employees, employees with multiple jobs at the airport, the number of flight crew personnel requiring parking that reside in an airport's catchment area but are based in a different city, events that require unscheduled overtime, and airport employment locations.

Table 5. Comparison of total airport employees and airport operator's employees at representative airports.

Airport	Total Airport Employees	Airport Operator Employees	Airport Operator Employees as a Percent of Total Airport Employees
Large Hub			
Boston Logan International (BOS)	14,000	850[a]	6%
Chicago O'Hare International (ORD)	50,000	1,500[b]	3%
McCarran International (LAS)	20,350	1,200	6%
Miami International (MIA)	35,000	–	–
San Diego International (SAN)	5,500[c]	335	6%
Seattle-Tacoma International (SEA)	22,000	833	4%
Tampa International (TPA)	6,500	625	10%
Washington Dulles International (IAD)	18,800	–	–
Medium Hub			
Bob Hope (BUR)	1,902	120	6%
Oakland International (OAK)	10,000	–	–
Port Columbus International (CMH)	3,500	360	10%
Portland International (PDX)	11,000	300	3%
San Antonio International (SAT)	–	440	–
Small Hub			
Huntsville International (HSV)	550	105	19%
Tulsa International (TUL)	2,000	170	9%

Notes:

– Data unknown or not available.

[a] Total Massachusetts Port Authority (Massport) employees at Boston Logan International Airport were reported as ranging from 800 to 900.

[b] Number of City of Chicago Department of Aviation employees reported for Chicago O'Hare International includes employees at both O'Hare and Chicago Midway International.

[c] Total employees at San Diego International were reported as ranging from 5,000 to 6,000.

Source: Ricondo & Associates, Inc., and DMR Consulting, based on airport case studies developed for ACRP Project 10-06. (*1–15*)

CHAPTER 2

Constrained Airport Parking Environment

Airport parking becomes constrained when the demand for parking spaces exceeds the available supply. The nature and severity of parking constraints vary from airport to airport depending on factors that affect the balance between supply and demand. These factors include total parking supply relative to total demand, the allocation of parking supply relative to the demand for specific parking products, airport operator policies pertaining to providing and operating parking facilities, the availability of alternatives to driving and parking at the airport for both airline passengers and airport employees, and external policies affecting the airport. The types of constrained parking, causes of constrained parking, and related consequences are discussed in this chapter.

Types of Airport Parking Constraints

Because it is impractical to manage a parking operation at 100% occupancy, airport operators typically define parking as constrained when occupancy exceeds a set percentage of capacity, based on operational experience. This percentage is referred to as the "functional capacity" of a parking facility or parking system. The functional capacity of parking facilities varies by airport, but generally ranges between 85% and 95% of supply. Regardless of the specific percent defined, once an airport operator considers parking to be constrained, the operator will make decisions related to parking based on this premise. It is the point at which the airport operator acts in response to the functional capacity constraint that is the key to defining whether or not an airport is operating in a constrained parking environment. Generally, public and employee parking constraints result from an imbalance between parking supply and demand under one of the three scenarios that follow:

- **Inadequate total parking supply**—Constrained parking occurs when the total demand for public parking or employee parking exceeds the functional capacity of the total available parking supply.
- **Lack of supply at an individual parking facility**—Constrained parking occurs when individual public or employee parking facilities do not accommodate the demand for parking at those facilities, while other facilities have excess capacity. For example, during peak leisure travel times, such as weekends and holiday periods, a short-term or daily parking facility may have excess capacity while the economy parking facility is constrained. This scenario differs from the previous scenario in that the total airport parking supply may be adequate to accommodate total parking demand, but the allocation of supply among facilities does not meet demand.
- **Imbalanced allocation of parking supply**—Parking allocated for specific uses does not accommodate demand during certain periods while parking capacity for other uses is sufficient or underutilized. The distinction between this scenario and the previous scenario is that multiple parking products or uses may be allocated to one facility. For example, many airport operators issue parking permits for airport employees to use terminal area public parking. Other airport operators designate a section of terminal area parking for short-term parking, with the remainder designated for long-term parking.

Parking constraints may occur occasionally or on an ongoing basis. Ongoing parking constraints typically occur on a weekly basis during busy periods whereas occasional parking constraints result from nontypical events, such as holiday periods, school vacations, or other events that generate nonroutine spikes in airline passenger activity. Strategies to address ongoing and short-term parking constraints are discussed in Chapter 5.

Causes of Airport Parking Constraints

Insufficient capacity is only one of the reasons an airport may experience constrained parking. Constrained parking conditions occur when the balance between supply and demand

Allocation Constraint at Seattle-Tacoma International Airport

Seattle-Tacoma International Airport has one public parking facility—an eight-level parking garage adjacent to the terminal area with designated areas for short-term parking, premium parking, and long-term parking. Employees with parking permits for the garage were able to access any available long-term space. In 2007, the Port of Seattle reallocated the number of spaces by product to achieve more efficient use of the garage. The reallocation included combining the hourly and premium parking areas, and requiring employees to park on the eighth floor. The eighth floor had been underutilized by revenue-generating customers who perceived it as being remote. The reallocation resulted in the availability of additional lower-level spaces for revenue customers, a more consistent and dedicated parking space supply for employees, improved overall use of the parking garage, and a reduction in the number of spaces dedicated to short-term and premium parking by cross-utilizing a combined, but smaller, inventory for those parking products. (*6*)

changes such that either (1) supply decreases (or does not increase at an adequate rate) relative to demand or (2) demand increases relative to supply. Many factors can influence both sides of this equation (e.g., a low-cost carrier begins serving the airport and stimulates demand for airline travel, or a public or employee parking lot is redeveloped for another use with no replacement supply). Therefore, it is important that parking capacity and parking demand be analyzed together when assessing the causes of constrained parking and when subsequently making informed decisions about the best ways to resolve constrained parking at a specific airport. The typical causes of constrained public or employee parking at airports are discussed in the following section.

Parking Supply Constraints

The parking supply at an airport may be limited for the following reasons:

- **Land constraints** may limit the physical area available for the development of on- or off-airport parking facilities, such as at airports where land is not available or ideal to accommodate parking, either on the airport property or in the vicinity of the airport.
- **Financial constraints** may limit the ability of an airport operator or a private operator to expand parking supply. Parking revenue is generally a significant component of an airport's financial operation and overall airport financial constraints are a major consideration when evaluating future airport parking expansion, particularly if a parking structure is under consideration. Although a new, structured parking facility at a constrained airport would likely result in incremental revenue, the resulting increase in an airport's debt service to finance a parking structure without sufficient offsetting incremental parking revenues in the initial years of operation could negatively impact an airport's overall debt service coverage ratio; thus, potentially increasing an airport operator's cost of capital.
- **Airport operator policies and regulations** may limit the ability of the airport operator to expand the parking supply for financial, land use, environmental, or other reasons. These policies may not relate directly to parking, but they influence the parking environment. For example, a land-use designation or policy to support rental car operations in the terminal area—land that could otherwise be used to accommodate parking demand—is an airport operator policy that could indirectly contribute to a constrained parking environment.
- **External policies and regulations** related to land use, airline passenger vehicle trip reduction, employee trip reduction, and other issues may limit the ability of an airport operator or private off-airport operator to expand the parking supply. For example, an externally enacted policy may restrict airport parking to encourage the use of public transportation; however, this policy may result in a parking constraint if the public transportation system does not offer the level of service or geographic coverage necessary to serve the airport's parking customers.

Influences on Parking Demand

Demand for airport parking may exceed supply for the following reasons:

- **An inadequate allocation of parking supply** may result in the demand for a certain parking product at an airport exceeding the supply of that product as a result of an imbalance in demand relative to the available supply. This imbalance could occur on a regular basis or sporadically, such as during peak days of the week or at peak seasons of the year. For example, increased leisure travel in the summer months may result in increased demand for economy

parking, thereby resulting in a constrained parking condition at that facility, while excess capacity exists in terminal area parking facilities.

- **A nonoptimized rate structure** can contribute to parking constraints if the differential in rates between parking products is too narrow or the parking products are not priced to effectively allocate and balance demand among parking products and other airport ground access modes. For example, parking rates for all parking products may be low in comparison to alternative ground access modes, which might result in a high proportion of airline passengers choosing to park rather than use alternative modes of ground access.
- **Changes in airline service** directly affect public parking demand. For example, the introduction of low-fare airline service at several airports has been shown to result in increased airport parking demand relative to the demand typically expected from legacy airline service. This increase results from several factors, including the effect of increasing the potential catchment area of an airport to airline passengers that typically would not travel by airline or travel at all. This change has resulted in a higher proportion of passengers that drive longer distances and that have a higher propensity to park at the airport. Also, an increase in the number of budget-minded airline passengers that can justify paying for long-term parking when considering the low cost of the airline ticket has a tendency to increase parking demand. In addition to the effect of low-cost carrier service, changes in airline schedules have an effect on the peaking patterns at parking facilities throughout the day, which can affect the availability of parking for greeters and well-wishers during peak periods.
- **External policy influences** can contribute to changes in parking demand at an airport. For example, local jurisdictions that have enacted legislation to promote employee trip reductions can affect airport employee parking demand.
- **Effects of previous experiences with congestion** are a consideration for airline passengers deciding on an airport access mode. For example, ongoing airport parking constraints may have artificially affected airport mode choice, resulting in pent-up demand that should be considered when developing solutions to constrained parking. Similarly, regional roadway congestion may change airline passenger travel behavior such that future regional improvements may result in changes in airport access and parking use.
- **Lack of ground access mode alternatives to the private automobile** may result in higher demand for parking facilities and, thus, a constrained parking environment at the airport. Alternative access modes may be viable if they are consistent with the following service characteristics:
  - Offer service hours and frequencies in alignment with airline passenger flight schedules or employee work schedules,
  - Provide geographic coverage for airline passenger origins or employee residences,
  - Offer fares that are acceptable in relation to the cost of driving and parking, and
  - Present reasonable travel times in comparison to the private automobile.

As discussed in Chapter 1, it is important to note that the cost of alternative modes of access and the time differential for an alternative mode compared with driving and parking at the airport are valued differently by business and nonbusiness airline passengers. Therefore, policies designed to address demand-side constraints will be more likely to achieve the desired results if targeted to the market segmentation of the airport's O&D airline passengers.

Effects and Consequences of Constrained Airport Parking

Consequences resulting from constrained airport parking are described in the rest of this section.

Customer Satisfaction

Parking customers who cannot easily find a parking space or are consistently diverted to other parking facilities must allow more lead time to travel to the airport. In many cases, the cus-

Causes of Airport Parking Constraints, Non-Airport Policies and Regulations, Portland International Airport

The Port of Portland operates Portland International Airport (PDX) under a conditional land-use permit from the City of Portland, Oregon, which, among other things, limits the number of public parking spaces that can be added at PDX and specifies where the spaces can be provided. The permit also requires the Port to charge airport employees a fee to park at PDX. The most recent permit was issued in 2003. (*12*)

Causes of Airport Parking Constraints, Nonoptimal Rate Structure, Chicago O'Hare International Airport

Prior to December 2007, the rate for the daily parking product at Chicago O'Hare International Airport's domestic terminals was $30 per day, equivalent to the rate for parking at the international terminal's short-term facility, which was intended to accommodate greeters and well-wishers. When daily parking facilities at the domestic terminals reached functional capacity and were closed, some parking customers diverted to the international terminal's short-term facility rather than to the remote economy parking products. These diversions were suspected to be the cause of constrained conditions at the international terminal's short-term parking facility. In December 2007, the parking rate at the international terminal's short-term lot was increased to $50 per day to discourage this unintended diversion of parkers. The new rate matched the daily rate for the hourly parking (short-term) product at the domestic terminals. Airport staff believe that this rate increase was successful in achieving their goal, and closures of the international terminal short-term lot have been reduced. (*2*)

tomer is unaware of the constraint until arriving at the airport, which can lead to an undesirable effect on travel plans, including missed flights. Increased travel time and frustration may make driving and parking at the airport less appealing in comparison to other modes of travel, including the use of a privately operated parking facility that competes for airport parking customers (where available). Airport operators may find it difficult to entice parking customers to return to on-airport parking facilities once those customers have chosen to park off-airport or use alternative airport access modes. Parking customers may choose to use alternative modes or privately operated parking facilities in the future, even during periods when parking at the airport is not constrained, which translates to lost parking revenue for the airport operator.

Airport Roadway Traffic Congestion

Airline passengers who would typically choose to park their vehicles may choose another mode to access the airport if they anticipate constrained airport parking. These changes may affect airport roadway traffic in the following ways:

- If an airline passenger is traveling from one parking facility to another while searching for a parking space, that passenger is adding vehicle traffic to the airport roadway system.
- If an airline passenger shifts from parking to being picked up and dropped off by private automobile for future trips, that airline passenger (or airline passenger party) will generate twice the number of vehicle trips—in the region, on local roadways surrounding the airport, and on the airport roadway system—than were generated when the automobile was driven to the airport and parked by the airline passenger. For each airline round trip during which the passenger party parks for the trip duration, a one-way vehicle trip is made to the airport when the airline passenger party departs, and a one-way trip is made from the airport when the airline passenger party returns. Conversely, when an airline passenger party is dropped off by private automobile, one two-way vehicle trip is made to and from the airport to accommodate the enplaning trip, and another two-way vehicle trip is made to and from the airport to pick up the same party upon its return. Similarly, a shift from parking to taxicab or single-party limousine mode also results in an increase in the total number of trips on the roadway system; however, the increase will not be twofold given that a portion of the taxicabs and limousines carrying an airline passenger party to the airport will transport a different airline passenger party departing the airport.
- If an airline passenger shifts from parking to an HOV mode, the number of vehicle trips in the region, on local roadways surrounding the airport, and on the airport roadway system decreases. In this case, the effect of constrained parking improves roadway traffic conditions.
- During constrained parking conditions, greeters who are picking up an arriving passenger and can not find a parking space may drive to the terminal curbside to pick up the arriving passenger. If the arriving airline passenger is not ready for pickup, the driver may be required to circle around the terminal area or travel to a cell phone lot (if available) until the airline passenger is ready to be picked up, which increases vehicle circulation on airport roadways.

Increased vehicle traffic and associated curbside congestion directly translate into increased vehicle emissions, as discussed in the following section.

Increased Vehicle Emissions

Total vehicle miles traveled (VMT) on the airport and the resulting emissions increase during constrained parking con-

ditions for the reasons described in the previous section. Increased air pollutant emissions also occur when a parking customer is forced to circulate within a parking facility while searching for an available space.

When airline passengers shift from parking to pickup and drop-off by private automobile, taxicab, or single-party limousine, the increased vehicle trips resulting from this mode shift generate more vehicle emissions on the airport and within the region than would be the case if these airline passengers parked for the duration of their trips. However, if the vehicle used in the drop-off and pickup mode generates lower vehicle emissions as the result of cleaner fuel technology than the vehicle that would have been parked, then the net change in emissions generated should be considered.

For shifts from airline passengers parking for the duration of their trips to HOV modes, the vehicle emissions generated should decrease. In this case, the effect of constrained parking may have a positive effect on vehicle emissions.

Increased Costs

Constrained parking conditions often require increased management on the part of the airport operator (or its parking operator) to direct parking customers from a temporarily closed facility to an open facility or to actively assist customers in finding an available space within a constrained facility. This increased management results in increased labor costs. When temporary overflow facilities are opened to accommodate excess parking demand, additional labor and operational costs will be incurred, including busing costs associated with operation of remote overflow lots and the costs associated with revenue collection, if applicable. Transportation will be required between the terminal area and the overflow facility until the driver of the last parked automobile returns from his or her trip.

Lost Revenue

Constrained parking generally results in lost airport revenue. For example, a missed revenue opportunity occurs for every parking customer that chooses to (1) shift from the public parking supply in favor of other modes, (2) downgrade to a remote facility at which a lower rate is charged, or (3) move to a privately operated off-airport parking facility.

Potential Diversion to Other Airports

Data from the stated preference survey conducted as part of this research project indicate that constrained parking is not a primary reason for airline passengers choosing one airport over another in an airport system. The primary reasons airline passengers choose one airport over another in a competing airport system are the availability of direct flights to a desired destination, the price of airline tickets, and flight travel time.

Airport Employee Retention

Airport employees are vital to the operation of an airport. One of the challenges airport employers face in recruiting and retaining employees is the availability of viable commute alternatives to the private automobile that accommodate work schedules. This is particularly true for part-time and temporary workers. Therefore, commute options to the airport must be convenient compared to commute options to other employment centers, such as a downtown area that is well served by public transportation. If the employee parking supply is constrained and the alternatives to driving do not accommodate work schedules or represent a significant time penalty compared to driving, airport employers will have a difficult time recruiting and retaining employees.

CHAPTER 3

Goals and Objectives for Managing Constrained Airport Parking Environments

Managers of airports where parking facilities are constrained may implement a range of strategies to manage the shortfall of parking supply at their facilities. The strategies they implement will likely be influenced or determined by the physical, financial, and political contexts within which they operate. Thus, no "one right" strategy exists to address constrained parking at all airports. Ultimately, the strategies developed and implemented will depend upon the goals and objectives established by the entity responsible for managing the airport. When clearly defined, these goals and objectives become the framework for developing and implementing strategies to address the constrained parking environment. These goals and objectives also form the basis for evaluating the effectiveness of the strategies implemented, as discussed in Chapter 8.

The severity of parking constraints is unique from one airport to the next and is largely dependent upon how airport managers view their parking operations. In some cases, public opinion and customer service standards may be the single greatest driving force when establishing strategies to address a constrained parking operation. In other cases, the financial position of the airport enterprise and priorities in the airport capital improvement program (CIP) may have an equal or greater influence on the strategies developed and implemented to address the parking constraint. Outside influences, such as mandated airfield improvements or local environmental policies and regulations, also may be significant considerations. Therefore, what may be viewed as an unacceptable constrained parking environment at one airport may be perceived as a preferred alternative at another airport.

Research conducted during preparation of this Handbook revealed several common themes that influence how goals and objectives for addressing constrained parking are established at representative airports. These goals and objectives are established based on multiple themes that include, but are not limited to, customer service, environmental impacts, on- and off-airport traffic impacts, community relations, airport capital improvement priorities, parking-derived revenue stream requirements, airport use and lease agreements, highest and best use of available land areas, and airport master plans and airport layout plans (ALPs).

The factors that influence an airport operator's parking program are discussed in the next section, followed by a discussion of the issues to be considered when developing goals and objectives for managing constrained airport parking.

Factors That Influence the Development of Goals and Objectives for an Airport Parking System

As discussed previously, a constrained parking environment at each airport is unique in that the severity of the constraint is perceived differently not only from one airport to the next, but often from one manager or policymaker to the next within the same organization. Thus, a direct relationship exists between how public and employee parking systems at an airport are managed and the policymakers (which may be external to the airport's management structure) who influence decisions regarding how new parking products will be developed. Often, decisions about programs not seemingly related to parking influence an airport operator's parking development strategy. For example, a CIP priority, such as the expansion of a central utility plant, may require capital funding that could otherwise be used for expanding parking facilities.

Because of the uniqueness of each airport's operating and management structure, political environment, and regulatory setting, it is not possible to list all of the factors that could influence the goals and objectives established for each airport. However, in discussions conducted during the research phase of this project with airport operators who are now managing, or have previously managed, constrained parking operations, several recurring influences emerged, as discussed in the following sections.

Internal Influences

Within an airport operating and management environment, generally agreed upon guiding principles influence day-to-day operations at the airport and set the framework for the future development of airport facilities. In some cases, customer service standards are determined to be so important that facilities are planned and maintained to provide exceptional levels of service above, potentially, all other considerations. In other cases, maximizing nonaeronautical revenues, including parking revenue streams, may be a major emphasis in order to reduce a high cost per enplaned passenger ratio for the airlines serving the airport. Whatever the situation, senior management, typically in conjunction with some type of oversight (such as a board of directors, mayor, or state transportation agency) sets the management philosophy for the airport, or what is referred to as the airport's "guiding principles." Although external influences are recognized and vary based on the governance structure of the airport (e.g., independent authority, city department, state agency), airport management's guiding principles, for the most part, set the framework for the goals and objectives for the airport's parking system. These guiding principles reflect the direction of management and consistently influence the day-to-day decision-making process of staff at all levels in the organization. In addition to airport management's philosophy, typically some form or range of policies, regulations, operating agreements, or constraints, whether obvious or subtle, influence the management of an airport parking system. The following categories were identified during this research project as the most common internal influences affecting how an airport operator manages and establishes the goals and objectives related to operating the airport parking system:

- **Financial**—Limitations on capital or operating funds affect an airport operator's ability to increase parking supply. Given that parking is such an important generator of revenues at an airport, net revenue generated from public parking is applied to fund other airport projects, used to lower airline fees, added to reserve funds, or needed to help meet debt service coverage as required in an airport operator's bond indenture.
- **Customer service**—A customer service philosophy or political sensitivities influence the planning and management of an airport parking system.
- **Traffic management and trip generation**—The airport operator is involved in efforts to reduce or limit increases in vehicle trips to and from the airport or to increase the share of customers using HOVs because of capacity constraints on on-airport roadways or the regional surface transportation network that serves the airport.
- **Environmental concerns**—The airport operator promotes environmental stewardship. For example, an airport operator may define an objective to reduce emissions generated as a result of operation of the airport, including vehicle emissions generated by airline passenger and employee traffic, and thus may promote programs and new technologies designed to reduce emissions generated by ground vehicles accessing the airport.
- **Land use**—The lack of available land under the jurisdictional control of the airport operator or sponsor and located within acceptable operational limits of the terminal area was noted as a significant influence on the establishment of an airport operator's parking goals and objectives. The lack of available land to support the development or expansion of parking facilities may be due to a scarcity of land or a determination by current or prior airport management to prioritize the use of available land for other purposes, such as terminal or airside expansion, rental car facilities, or hotels.

External Influences

Some airports are subject to policies and regulations imposed by outside governing bodies, or the airport operator is party to agreements with outside entities that influence the operation and management of the airport parking program. Most, if not all, airports are subject to influences from entities such as local economic development advocacy groups or agencies, or chambers of commerce. In most cases, airport policymakers work cooperatively with local business groups to promote tourism and improve customer service. However, external influences can negatively affect the airport operator's ability to address constrained parking environments. Examples of such external influences include the following:

- **Community**—The airport operator is involved in mitigating airport-related impacts, which may include traffic or emissions generated within the airport boundary, in surrounding communities, or in the region. Some airport operators have entered into formal agreements with governing bodies or community groups to enable airport development programs to go forward. In some cases, these agreements can restrict the degree to which parking can be expanded at the airport.
- **Environment**—The airport may be subject to environmental mitigation commitments at the federal, state, or local level, that involve, for example, goals to reduce airport trips or VMTs to reduce vehicle emissions. In some case, these commitments must be met through the use of parking demand management strategies that effectively limit the amount of parking that can be supplied at the airport.

Examples of External Policies Influencing Parking Programs at Boston Logan, Portland, and Seattle-Tacoma International Airports

Boston Logan International Airport (BOS) Parking Freeze—The public and employee parking supply at BOS has been constrained for a number of years, primarily as the result of a regulatory restriction on the parking supply (i.e., a parking freeze) at BOS that became effective in 1975, in accordance with the Commonwealth of Massachusetts and federal air quality regulations. The public parking supply at BOS can only be increased by permanently converting employee parking spaces to public parking spaces; the on-airport employee parking supply can not be increased. (*1*)

City of Portland Conditional Land-Use Permit—The Port of Portland operates under a conditional land-use permit from the City of Portland that, among other things, limits the number of public parking spaces that can be added at Portland International Airport (PDX) and specifies where the spaces can be provided. The permit also requires the Port to charge airport employees a fee to park at PDX. The most recent permit was issued in 2003. Until recently, there was a general understanding by the local regulatory agencies (the City of Portland, the Portland MPO, and the state of Oregon) that parking spaces induce automobile trips, and that limiting parking spaces anywhere (including PDX) will encourage alternate modes of travel. A new airline passenger demand component in the regional travel demand model in use since 2009 has been effective in beginning to change the understanding of regulators regarding how airport parking behavior differs from the behavior of parkers visiting other types of activity centers such as an office building. It is expected that this new understanding will be reflected in approval of a new land-use permit in 2010. (*16*)

City of SeaTac Limitation on Off-Airport Parking—Port of Seattle staff consider the privately operated off-airport parking supply an important component of the overall parking supply at Seattle-Tacoma International Airport (SEA) that helps to relieve public parking constraints during overflow conditions. However, the adjacent City of SeaTac has enacted a policy limiting the off-airport parking supply, so an increase in off-airport parking is not likely to be a solution to future parking constraints at SEA. Furthermore, the policy would prevent the Port of Seattle from leasing or purchasing land in the City of SeaTac for temporary parking use when the public parking supply at SEA is constrained. (*6*)

- **Transportation**—The airport operator and its tenants may be required or encouraged to mitigate transportation impacts. This requirement or encouragement may be part of a regional transportation planning effort aimed at reducing trips generated by all users of an airport or trips generated by specific user groups at an airport. Large employers at airports may be subject to employee commute regulations imposed by local governing bodies. These employee commute regulations may be aimed at increasing the average vehicle occupancy rate or reducing vehicle trips. Additionally, airport operators who seek federal funding assistance through a metropolitan planning organization (MPO) or similar type of organizational structure can be subject to specific requirements in return for funding commitments.
- **Zoning and land-use policies**—Airport property may be regulated by local zoning or land-use policies. Adjacent communities may have adopted land-use policies that limit the amount of parking to be provided. The governance structure of the airport has a significant effect on the degree to which zoning and local or regional land-use policies affect decisions related to airport parking.

Developing Goals and Objectives

Goals and objectives for airport parking should be developed within the framework of the overall goals and objectives for the airport. Priorities should be established that are consistent with the guiding principles of airport policymakers and the parking development program should be integrated into the airport CIP. These goals and objectives will not only guide the development of strategies for resolving parking constraints, but will also serve to screen out strategies that are inconsistent with broader policy objectives or that do not have a reasonable chance of achieving their desired results. Within the context of the goals and objectives, airport management will be able to develop monitoring programs, whether financial, operational, or other, to evaluate the effectiveness of strategies implemented to further policy objectives.

One method of developing goals and objectives and prioritizing them is to compile a list of questions or scenarios to explore, have staff and executives consider them, and then work together to develop and prioritize them. Examples of questions that may be considered in this process include the following:

- Is the airport operator obligated or inclined to provide a parking space for every customer that desires one, including a space within the facility in which the customer wishes to park?
- What are the financial implications and tolerance levels for losing parking market share to private parking operators? Have concerns about the loss of market share caused the airport operator to be tentative in its approach to addressing on-airport parking constraints?
- What is the relationship between customer convenience and net revenue?
- What role should the airport operator play in providing employee parking facilities?
- Where is the best location for public parking versus rental car ready/return and quick turn-around areas?
- Is improved customer service for resident O&D passengers a higher priority than the convenience of picking up a rental car for nonresident O&D passengers?
- Should the pricing of public or employee parking be used as a tool to influence demand? If pricing has been used to influence demand, has it been used effectively?
- Is a comprehensive approach being taken for providing public or employee parking in relation to overall policies for airport ground access and land use, including the establishment of the highest and best use of available land?
- What is the tolerance for capital investment in the parking program in relation to the overall CIP for the airport?
- What is the return on investment for expanding existing parking facilities and what are the options?

Considerations in developing goals and objectives related to the provision and management of public or employee parking in relation to financial, customer service, traffic management and mode share, environmental, and land-use objectives are presented in the following sections.

Financial Objectives

Financial objectives may be related to net revenue, operating and capital costs, and financing (i.e., the ability to borrow money for CIPs). Parking rates should be developed based on financial objectives, as well as other objectives, considering the perceived or actual price tolerance of airline passenger and employee parking customers. The provision of additional capacity or new parking products, or the implementation of new technology all will be influenced by financial objectives.

Net Revenues

Net fees derived from public parking operations typically are a key revenue source available to repay debt service resulting from revenue bonds issued to fund airport capital expansion projects. As such, airport operators often look to increase parking-derived revenue streams in order to retire bond obligations used to finance capital programs.

Many parking-related capital projects do not have complementary, direct supporting revenue streams (e.g., service area improvements and public roadway upgrades, among others) or adequate supporting revenue streams (e.g., employee parking facilities). Net revenue generation must take into account the ability to support those types of projects as well as direct revenue producing capital projects. Additionally, rather than simply covering the capital or operational requirements for parking and related facilities, net parking revenues could be a significant source for repayment of other airport debt and operating expenses.

Net revenues derived from parking are directly related to parking system operating expenses. Managing operating expenses is one way an airport operator can improve margins (net revenues) without increasing gross revenues (i.e., raising parking rates) generated by the parking system. Key operating expenses at most airports include direct and allocated indirect expenditures and costs associated with shuttle bus operations. Ironically, shuttle bus operations often represent one of the largest recurring operating expenses for an airport parking system, yet only serve parkers who choose the lowest cost parking option (remote parking products) available. Therefore, remote parking products typically have the lowest net revenue margins.

Costs

Operating cost efficiencies enable the airport operator to realize higher net revenues or to contain parking rates. Managing constrained parking with temporary solutions often involves additional personnel, busing costs, and other operating costs. There may be a breakeven point where the costs to provide the temporary solutions are better applied to permanent solutions, such as new technology or additional capacity. An example would be an airport where a remote parcel of property is used as temporary overflow parking 20 days per year. The revenue from the overflow parking versus labor, busing, and other operating costs expended would be compared to the net revenue of developing a permanent solution. The net revenues from the overflow operation compared with the net revenues from the potential permanent solutions would provide the answer.

As mentioned in the previous discussion of net revenues, the airport operator's goals and objectives regarding financial performance in relation to capital costs is important, such as the rate of return from a new facility, the timeframe for a new

facility to achieve cost recovery, or the efficiencies or net revenues that investment in new technology may provide.

Financing

The relationship between financing a capital investment in the parking program and the ability to obtain project financing for other projects in the capital program is an important consideration. Even if the projected financial performance of the new parking facility is acceptable to the airport operator, financing of the project may inhibit the airport operator's ability to borrow money for projects that are of higher priority in the airport CIP.

Employee Parking

Financial objectives for the provision of employee parking should include consideration of the financial objectives of the airport operator. If employee parking is operated on a cost recovery basis, will costs be recovered through parking fees charged to employees using the parking facilities; will tenant employers reimburse the airport operator for its operating costs; or will a large airport employer (such as a hub airline) provide parking for its employees? Alternatively, an airport operator may decide to operate employee parking at a loss and cover operating cost with revenues generated by other sources at the airport (e.g., public parking facilities). Ultimately, the decision of how to cover the cost of providing employee parking at an airport will depend on the operating agreement with airport tenants and the business model objectives of the airport operator.

Customer Service Objectives

The level of customer service the airport operator wishes to provide to the various groups of airline passengers and employees who are airport parking customers influences how decisions are made regarding the provision of public and employee parking. The level of importance attributed to customer service will directly influence how an airport operator will resolve parking constraints. Level-of-service considerations for the development of objectives pertaining to public and employee parking are summarized in the remainder of this section.

Public Parking

Customer service considerations for the development of objectives for passengers using public parking include the following:

- Proportion or amount of parking supply to be provided in the terminal area and the customers that will benefit from it;
- Proportion of parking supply provided away from the terminal (i.e., remote) and the implications regarding customer level of service, including shuttle frequency and walking distance to board/alight parking shuttles, and the total travel time to and from airline terminals;
- Parking products and range of parking rates offered;
- Identification of customers that will benefit from the introduction of premium parking products and, if already offered, assessment of whether customers targeted for premium parking products are using and benefiting from them;
- Level of information to be provided to customers regarding parking availability, and how that information will be conveyed;
- Implementation of technology commensurate with customer service wants and needs;
- Ways to resolve parking constraints in line with management's customer service philosophies (guiding principles);
- Safety and cleanliness of the parking facilities; and
- Methods for measuring customer satisfaction.

Employee Parking

Customer service considerations for the development of objectives for employee parking include the following:

- Convenience in terms of location or walking and travel time to the place of employment;
- Safety and cleanliness of facilities;
- Employee parking fees;
- Importance of how the provision of employee parking (amount and level of service at parking facilities) affects employer and employee satisfaction;
- Availability of viable commute alternatives to driving to the airport and parking;
- Ways in which improvements and promotions of employee commute alternatives, including carpooling and ride-matching (a service intended to facilitate carpooling by pairing up commuters from similar origins who are destined for similar employment centers, such as an airport), will facilitate more efficient use of the employee parking supply;
- Employee parking level-of-service standards;
- Collective bargaining agreements, if applicable, and responsibility to ensure compliance; and
- Methods for measuring customer satisfaction.

Traffic Management and Mode-Share Objectives

In determining traffic management objectives for the parking program, the effects of the operation and management of the program on the volume of airline passenger or employee

trips generated within the boundaries of the airport, on local roadways, and within the region may be considered. Mode-share objectives incorporate consideration of the relationship between the parking program and the mode-share distribution of airline passengers or employees. It should be noted that traffic management and mode-share objectives may only be applicable at some airports, such as those in urban areas where traffic is a concern or those where operational sustainability objectives are key considerations for airport policymakers.

Traffic Management and Trip Generation

The volume of vehicle traffic generated by the airport and congestion on the regional surface transportation network that serves the airport may affect the airport operator's capital and operating costs, including costs for infrastructure and programs to promote the use of alternative forms of transportation to and from the airport. More efficient traffic management results in lower infrastructure and management costs.

Considerations in developing traffic management and trip generation goals include the following:

- **Trip generation on the airport roadway system, on local roads, and on the regional road system**—Understanding the relationship between public parking capacity and trips made by single-party access modes with a higher trip generation rate (i.e., customers being picked up and dropped off by private automobile, taxicab, and single-party limousines) and developing an acceptable balance between accommodating parking demand and diversion to single-party pickup and drop-off modes. The diversion from parking to HOV modes will result in fewer vehicle trips.
- **Trip generation on the airport roadway system**—Understanding how parking policies, such as the provision of the cell phone lot, or a shortfall of short-term parking spaces influences the volume of recirculating trips on the airport roadway system.
- **Policies and strategies**—Understanding how public parking policies, in conjunction with strategies for other access modes, may influence vehicle trip generation by airline passengers.
- **Employee trip generation**—Understanding the relationship between employee trip generation and the availability of other airport access modes.
- **Data**—Ensuring the collection of reliable baseline data from which to measure progress.

Mode-Share Distribution

The airport operator may wish to develop goals and objectives related to airline passenger or employee mode-share distribution that are separate from traffic and trip generation goals. The motivation for developing separate goals and objectives may be related to the desire for more passengers or employees to use HOV modes, either for environmental reasons or to defer the need for parking capacity increases. The desire to defer parking capacity increases could also lead to the adoption and implementation of strategies to encourage the use of single-party pickup and drop-off modes if traffic implications were not a concern.

Considerations include the following:

- The airline passenger or employee perception of the availability of transit and other HOV modes compared to their viability for airline passenger and employee travel to and from the airport (measures of viability include the geographic coverage of the service area, trip schedules, service frequencies, and travel times to accommodate airline passenger and employee travel needs);
- An understanding of airline passenger and employee mode-share distribution, which is integral to the development of goals and objectives and the measurement of progress; and
- The level of effort and influence the airport operator is willing or able to exert on the provision and operation of alternative modes to effect desired changes in mode choice.

Considerations for Airport Parking and Other Access Modes

When developing and evaluating airport policies and airport management goals and objectives, consideration should be given to the relationships between airport public parking, airport employee parking, and other ground access modes.

Public Parking. Policy decisions to accommodate airport employee parking or rental car parking and service facilities on the airport can contribute to constrained public parking operations when land available for landside facilities is scarce. For example, it is common for airport operators to grant some employees access to public parking facilities in the terminal area and, in some cases, employee use of public parking facilities may be responsible for displacing airline passengers who wish to park in the terminal area. It is important for airport operators to understand the volume of airline passenger parking being displaced by other users of the public parking supply, such as employees.

Rental Cars. When determining when and where to expand public parking, airport operators must consider a variety of competing objectives. One very good example is rental car ready/return areas and quick turnaround facilities for rental cars. Similar to public parking, revenues derived from rental car transactions and land leases can be one of the highest nonaeronautical revenue sources available to the airport

operator. Furthermore, airports with a high number of nonbusiness, nonresident airline passengers often have a local economy that is dependent upon the hospitality industry, resulting in external influences to maintain high levels of customer service for rental car customers. Not surprisingly, decisions on where to locate employee, rental car, and public parking facilities may be made using a set of goals and objectives based on the important issues at the time. Consequently, new strategies involving relocation of one parking product at the expense of another can be both politically challenging and costly. Depending upon the size of the local parking and rental car markets, public parking and rental car facilities can coexist in a shared facility. In other cases, they can not. Understanding the need for both types of parking operations is a significant influencing factor when determining the goals and objectives for airport parking facilities.

HOV Modes. The relationship between decisions regarding parking and HOV modes is often considered at airports with a wide selection of HOV modes or where transit connections to the airport are available. In some cases, there is a relationship between these modes so decisions related to one mode may influence the use of the other mode; however, at some airports, the available HOV modes may not be viable options for airline passengers or employees because of the differential in travel times compared to the private automobile or other single-party modes, the geographic coverage of the service area, and the trip schedules in relation to the airline passengers' travel needs. Furthermore, research conducted for this project indicated that constrained public parking conditions at airports lead to a higher increase in pickup and dropoff activity by airline passengers than to increased use of HOV modes. This result applies to airports that offer a range of HOV options as well as those that offer limited HOV options.

Employee Parking. The cost of operating employee parking should be considered in relation to the cost of subsidizing transit. For example, if the employee cost for a monthly parking pass at an airport is less than the price of a monthly transit pass, it may serve as a disincentive for employee transit use. This disincentive not only undermines the ability of the airport operator to reduce employee vehicle trips, but it also presents a financial operating loss to the airport operator if the cost for providing employee parking is not recovered. It should be noted that many transit systems do not operate a schedule that caters to all airport employees. Transit systems typically end service late in the evening and begin service early the next morning. For airports that have a significant shift change during late-night hours (particularly airports hosting hubbing airline operations) and for those airport tenants whose employees work during off-peak hours (e.g., janitorial and maintenance crews), public transit may not be a viable transportation option.

Environmental Objectives

Environmental objectives for the parking program provide guidance for management and operation of the parking program that may take into consideration the environmental impacts of trips generated. In addition, the relationship between more efficient fuel technologies and the parking program is another important consideration, especially for those vehicles that the airport operator controls. For example, the provision of shuttle service using alternative fuel vehicles between remote public parking areas and the terminal area or between employee lots and places of employment, the requirement that off-airport parking operators use alternative fuel vehicles in their shuttle bus fleets, the provision of an APM system to transport customers between parking and the terminal area or places of employment, and the balance between parking within walking distance of the terminal area and parking in remote locations all have environmental implications.

Land-Use Objectives

Land-use objectives as they relate to the parking program provide guidance for management and operation of the parking program. These objectives may relate to the proximity of parking for the customers served or the income-producing potential of the property, or other preferences. An example would be the airport operator's desire to locate public, employee, and rental car parking in areas where it represents the highest and best use of the property, considering the net revenue the property will generate. For remote parking, the net revenue calculation would include the cost to operate shuttle service between the parking area and the terminal area or places of employment.

CHAPTER 4

Predicting Public Parking Constraints

Several methodologies for predicting when airport public parking will become constrained are discussed in this chapter. By establishing or improving the predictive tools used to identify when parking constraints are likely to occur, parking operations staff will be better prepared to manage the situation, and strategies can be implemented prior to and during the constrained period—whether ongoing or occasional—to reduce the effects of constrained parking on the airport and its parking customers.

Prediction methodologies fall into the following three general categories:

- Tracking historical parking patterns,
- Projecting airline passenger activity, and
- Possessing operational experience and knowledge of parking patterns.

Airport operators and others conducting analyses on their behalf (such as parking management companies and consultants) often use a combination of all three methodologies to predict future parking constraints.

Historical Parking Patterns

Airports often experience public parking constraints because of increased activity in certain customer segments, such as the following:

- Business airline passengers on a specific weekday, such as a Tuesday;
- Nonbusiness airline passengers during holiday periods, such as Thanksgiving, Christmas, New Year's Day, and Easter;
- Nonbusiness airline passengers during school vacation periods, such as spring break, summer vacation, or holidays; and
- Nonbusiness airline passengers on weekends, especially long weekends.

Parking facility utilization data can be analyzed in detail to obtain information pertaining to the duration, location, and severity of historical constraints, which can then be used to predict the duration, location, and severity of future constraints. The historical data are most effectively interpreted in the context of historical enplaned passenger data to develop a relationship between airline passenger activity and parking activity.

No single indicator can be used by all airport operators to predict future constrained parking situations, whether they are temporary events or sustained periods of time when parking is routinely unavailable to all customers who wish to park. Airport operators must develop an understanding of the unique demand characteristics for parking at their facilities. Airport operators must recognize trends or market changes that may lead to more frequent or more sustained constrained parking periods and proactively adjust strategies used to manage the constrained parking situation at the airport.

Several methodologies used by airport operators to predict future constrained parking events are discussed in the remainder of this section. Some of the data can be obtained from the parking revenue control system, while the collection of other data requires manual or computer-assisted inventories of parking facilities. In many cases, these manual or computer-assisted inventories (e.g., daily license plate inventories of parked vehicles) of parking facilities are routinely conducted. It is important that airport operators identify the data that are most useful to understanding the constraints at their airports and ensure that the needed data are captured and archived for future use and interpretation.

Monitor Parking Occupancy Data by Facility

Parking occupancy data, such as overnight counts by facility, can be used as a benchmark to understand trends related to constrained parking conditions. For example, an overnight occupancy count reaching a certain percentage of the facility's capacity may be a good indicator that the facility will be constrained the next day.

Monitor Exits by Facility

Vehicle exits by facility by length of stay can be used to identify a trend toward constrained parking conditions. These data provide information on changes in the turnover of parking spaces in a facility. Lower than normal turnover during busy periods, even without a large increase in activity, is one cause of parking constraint. In this example, constrained parking conditions may be attributed to airline passengers parking for longer durations than during unconstrained periods.

Get Information on Previous Constrained Parking Events

Tracking and monitoring parking data during previous periods of constrained parking, by using data on parking operations staff resources deployed to manage the constrained operation or data from the parking revenue control system, can be useful in predicting the frequency, nature, and consequences of future constrained operations for similar time periods. Data that may be collected and reviewed include the following:

- The number of days that overflow parking is required,
- The duration of each overflow event,
- The number of automobiles parked in excess of functional capacity by facility and by time of day,
- The duration of closures by facility,
- The number of days until the majority of automobiles were retrieved from overflow parking,
- The number of automobiles that were directed to privately operated parking facilities,
- Personnel overtime hours and days,
- Overflow shuttle service hours, and
- Hours of operation of overflow parking facilities.

Passenger Projections

Information on future flight bookings or other estimates of upcoming passenger activity can be used to project parking demand and periods when parking may become constrained. This information is useful when considered in conjunction with historical information on busy parking periods (as discussed in the previous section). Flight booking information can be obtained from the airlines; such information is proprietary, so it may not always be available to the airport operator. This information is most useful for near-term projections given the nature of airline passenger bookings. A comparison of changes in historical parking data to changes in airline passenger activity for the same time periods enables the analyst to determine changes that may be related to parking constraints and disregard changes that are related to fluctuations in airline passenger activity. This is referred to as normalizing the data.

Operational Experience and Knowledge

Personnel involved in airport public parking management and operations develop a general understanding of parking patterns based on experience. This knowledge assists these personnel in anticipating and planning for constrained parking events, and it is invaluable when interpreting historical data and projecting demand to predict future constrained parking events.

Predicting Parking Constraints at Tulsa International Airport

The Tulsa Airport Authority reviews overnight counts in the garage adjacent to the terminal area at Tulsa International Airport to predict overflow conditions. When overnight occupancy reaches 75% of capacity, the garage is likely to experience constrained conditions the next day. (*15*)

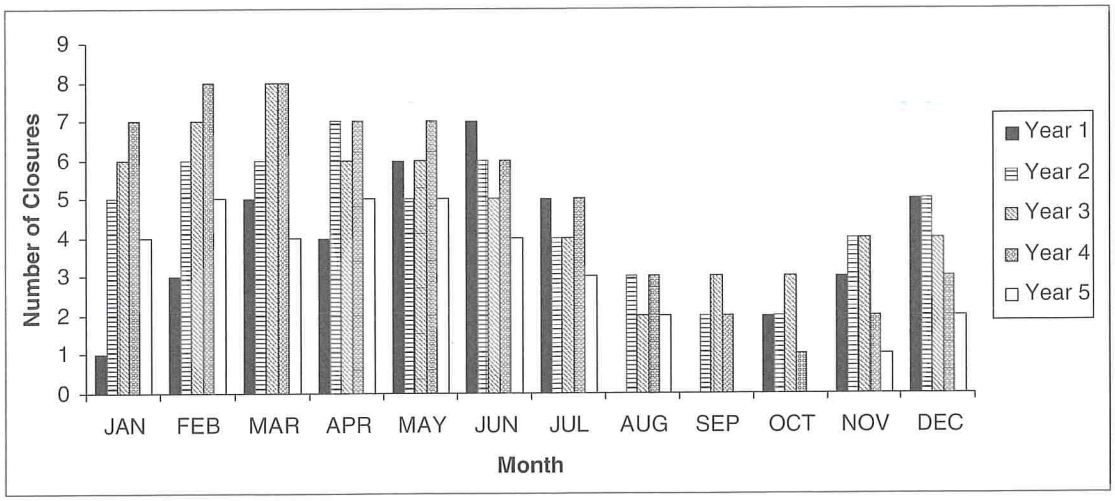
Predicting Parking Constraints at Bob Hope Airport

The Burbank-Glendale-Pasadena Airport Authority and its parking management operator project trends in parking facility use at Bob Hope Airport (BUR) by reviewing future airline bookings. The airlines share proprietary booking information with the authority and the parking operator on a regular basis. Strategies for dealing with constrained parking are based on this information, as well as experience, since passenger numbers do not always equate to parking exits. Depending on the type of event (e.g., holiday, weekday peak), different mixes of curbside traffic and parking exits will result. Parking staff pay attention to travel trends, such as when large conferences are happening in Las Vegas, since BUR is a Las Vegas gateway. (*9*)

Predicting Parking Constraints at Chicago O'Hare International Airport

The City of Chicago Department of Aviation and its parking management operator track several parameters related to historical public parking activity at Chicago O'Hare International Airport (ORD). These parameters, along with future airline bookings (proprietary information from the airlines), have proven useful in predicting future busy periods in which parking demand may approach or exceed the number of parking spaces in service in particular facilities. The historical information tracked includes the number of closures and hours closed by parking facility by month. These data are maintained for several years and presented in both tabular and bar chart formats to facilitate comparison and interpretation of the data. (*2*)

An example of historical data used to track the number of parking facility closures by month and to predict future parking constraints is presented below. The example presented below is based on the format used at ORD, but data are for illustration purposes only.

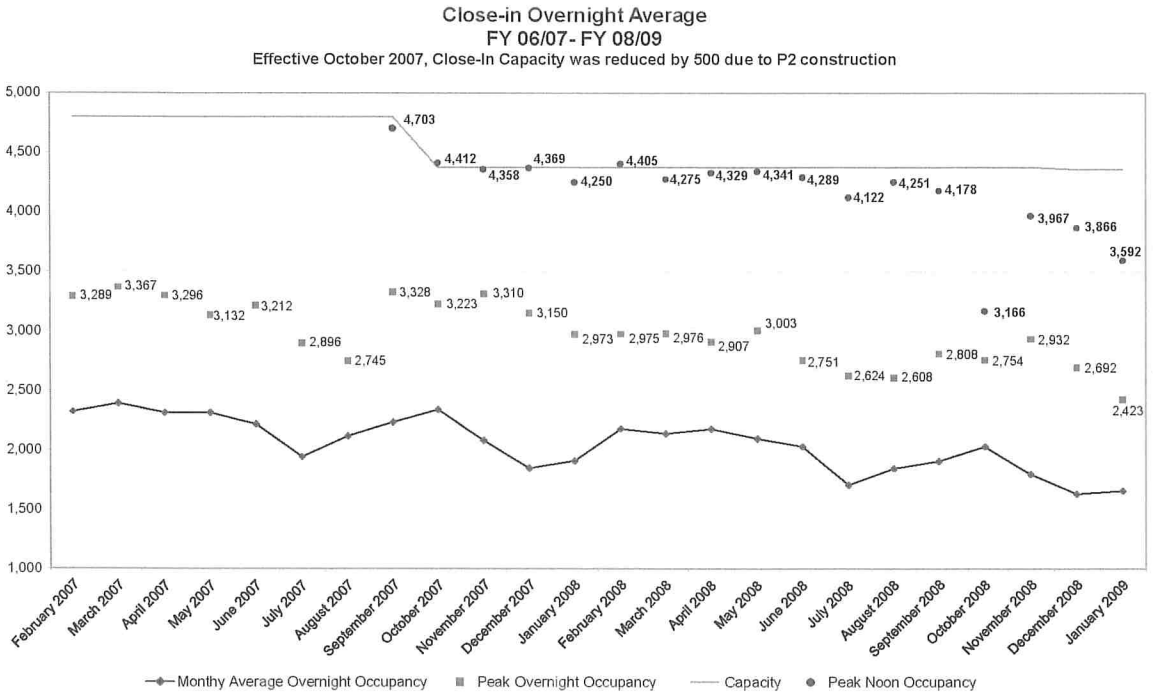


	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Year 1	1	3	5	4	6	7	5	0	0	2	3	5	41
Year 2	5	6	6	7	5	6	4	3	2	2	4	5	55
Year 3	6	7	8	6	6	5	4	2	3	3	4	4	58
Year 4	7	8	8	7	7	6	5	3	2	1	2	3	59
Year 5	4	5	4	5	5	4	3	2	0	0	1	2	35

Representative data for illustration purposes only.

Predicting Parking Constraints at Portland International Airport

The Port of Portland tracks parking activity at Portland International Airport on a daily basis and projects potential peak parking times by reviewing historical parking data and by comparing the data to proprietary booking information received from the airlines. Port of Portland staff have a sense of the busiest times for parking based on past activity. They develop graphs to project future activity. In 2006 and 2007, if overnight counts in the garage reached 1,700 to 1,800 automobiles, slightly higher than 50% of capacity, it was a good indication the garage would reach capacity by noon the next day. The following chart was developed by the Port of Portland to track the average overnight vehicle count by month, as well as the peak overnight vehicle count for each month, and the noon peak count for each month for all close-in parking. This chart consolidates occupancy information for the garage and the long-term lot, which are in the terminal area and are served by shuttle bus service. (*12*)



Sample Tracking Data—Average and Peak Overnight Occupancy and Peak Noon Occupancy by Month for Terminal Area Parking Facilities at Portland International Airport (17)

CHAPTER 5

Strategies to Address Constrained Public Parking

The variety of strategies airport operators may consider when addressing constrained public parking conditions are discussed in this chapter. Some strategies are intended to resolve ongoing constraints, while others are short-term operational solutions that are intended to address a specific constrained parking period or event, such as a holiday or spring and summer vacation periods.

Strategies discussed in this chapter are categorized according to whether they are best suited to address an ongoing or a short-term constraint; however, airport operators may find that a strategy typically used by other airport operators to address short-term constraints suits that airport operator's needs to manage an ongoing constraint. The financial, vehicle traffic, environmental, and customer service considerations for each strategy are presented at the end of this chapter to facilitate the comparison of considerations among strategies. Subsequent chapters related to strategies that address or resolve constrained parking conditions include the following:

- Chapter 6 presents methodologies to predict the outcomes of strategies under consideration.
- Chapter 7 provides guidance on how to select the most appropriate strategies from among those under consideration.
- Chapter 8 presents information on ways to evaluate the effectiveness of strategies that have been implemented at an airport.

Strategies to Respond to Ongoing Constraints

Strategies in this category are largely intended to resolve, prevent, or manage an ongoing parking constraint. These strategies require advanced planning, often require capital investment, and may require executive or regulatory approval. Sometimes an airport operator will adopt more than one strategy to resolve public parking constraints.

General strategies included in this category are as follows:

- Increase public parking supply,
- Introduce new parking products,
- Reallocate supply among public parking products,
- Adjust parking rates,
- Introduce technology improvements, and
- Promote use of HOV modes.

Increase Public Parking Supply

This strategy involves increasing the parking supply to accommodate demand, which can be accomplished by increasing the number of permanent public parking spaces or by providing additional parking spaces on a temporary basis during busy periods, referred to as overflow parking.

Permanent Parking Inventory

An airport operator can add capacity to the public parking inventory in several ways—by providing a new parking facility, by adding capacity to an existing parking facility, or by reassigning parking spaces used for a different purpose to public parking. Reassigning other parking spaces to public parking typically involves converting spaces previously assigned to airport employees or rental car companies.

Overflow Parking Inventory

An overflow parking facility is typically defined as an area not regularly in service for public parking that may be used for parking during periods when parking is constrained. These facilities are opened only when needed. The overflow facilities may or may not be owned by the airport operator and can

include paved parking lots, gravel or grass parking areas, or other available land suitable for parking. Typically, and especially at large airports, overflow parking facilities are located remotely from the terminal area and require a dedicated shuttle bus service. The airport operator may or may not charge a fee for use of an overflow parking facility.

The airport operator may choose to direct all parking customers to the overflow facility when the permanent facilities reach capacity, may provide customers with a choice of the overflow or permanent parking facilities before the permanent facilities become constrained, or may direct certain customers to the overflow facility based on a travel characteristic, such as trip duration.

Introduce New Parking Products

New parking products may be introduced to improve or resolve the constrained parking condition at an airport and to provide a desired service for (1) all public parking customers, (2) customers using specific parking facilities, or (3) a specific group of customers. A new product may be offered using the existing parking supply or through the provision of additional parking. Appropriate new products to address parking constraints will vary by airport, but examples include the following:

- **Valet parking**—The provision of valet parking offers parking customers the experience of parking in a convenient location adjacent to the terminal. Valet-parked automobiles may be stored remotely and then returned to a close-in staging area on the day a parking customer is scheduled to return. This limits the use of space in the terminal area dedicated to private automobile parking. Alternatively, vehicles can be stored within the terminal area if space is available, which improves operational efficiency for the valet parker since automobiles would not have to be shuttled between the terminal area and a remote storage area.
- **Cell phone lot**—Offering a cell phone lot is a possible solution to address heavy curbside congestion resulting from a high volume of automobiles dwelling at the curbside while waiting to pick up arriving passengers. Cell phone lots may also be used to reduce the demand for short-term parking.
- **Premium parking products**—These parking options include a range of products and programs that cater to long-term parking customers who prefer close-in terminal area parking (such as the business traveler) and who are willing to pay a premium for the product. Premium parking products that provide a guaranteed terminal area parking space can be a reliable solution for certain travelers concerned about airport parking constraints. Airports where premium parking products are offered generally realize improved parking-derived revenues and enhanced customer service for their premium parking customers.
- **Short-term parking**—Long-term parking spaces have lower turnover rates than do parking spaces accommodating short-term parkers. If these long- and short-term parkers are accommodated in the same facility, the spaces used by long-term parkers will "consume" the available spaces such that spaces are no longer available for short-term parkers. Segmentation of the terminal area parking to provide dedicated short-term spaces priced to discourage use by long-term parkers can help the airport operator accommodate demand for short-term spaces, which, in turn, improves curbside operations and reduces recirculating trips on airport roadways (especially when cell phone lots are not available). Successful implementation of this strategy requires excess capacity to accommodate long-term parkers in other parking facilities.

Reallocate Supply among Public Parking Categories

This strategy involves the reallocation of space among existing parking products to balance capacity with demand for individual parking products. Achieving the appropriate balance between short-term and long-term parking in the terminal area is a common problem, because needs vary by day of the week and time of the year. Sometimes, this problem can be resolved through permanent reallocation of space that improves the balance among products and meets the needs of

New Valet Parking Product at San Diego International Airport

The San Diego County Regional Airport Authority began offering valet parking to customers at San Diego International Airport (SAN) in February 2008 to reduce demand for self parking in the terminal area. According to authority staff, passengers using terminal area parking at SAN desire immediate terminal access when they arrive at, and depart from, the airport and are not price sensitive. The curbside valet parking service improves customer service by increasing the number of parkers who have the convenience of terminal area parking without increasing the supply of terminal area self-parking spaces. (*5*)

Varying Parking Supply Allocation at Tulsa International Airport

A total of 1,929 spaces are offered in the short-term and long-term parking facilities in the terminal area at Tulsa International Airport. Of these 1,929 spaces, 111 spaces can be designated for either short-term or long-term parking depending on what the Tulsa Airport Authority determines is needed to accommodate parking demand. The designation of these spaces is controlled by adding or removing signs. (*15*)

parking customers most of the time. Another solution is to dynamically vary the allocation of parking space in response to changes in demand through the use of variable signage, the use of movable barriers, or the designation of "swing" spaces that can be used for either long-term or short-term parking.

Adjust Parking Rates

Parking rates can be adjusted to balance demand among facilities, reduce demand for a specific facility, or reduce demand for the entire public parking supply. A curbside drop-off fee is another potential strategy that may influence parking demand. Several parking rate strategies, as well as the potential for a curbside drop-off fee, are discussed in this section.

Traditional Parking Rates

Traditional parking rates may be adjusted as a means to shift passenger parking demand among facilities or to reduce the demand for parking. Such adjustments are typically based on a detailed analysis of the relationship between parking transactions, demand, and revenue as they are affected by relative changes in hourly and daily rates within a facility, between parking products, and between on-airport and off-airport facilities. Alternatively, the adjustment may be based on an assessment of what the market will bear. A common concern among airport operators is that a dramatic increase in parking rates may result in a significant loss of parking customers and parking revenues to privately operated off-airport facilities or may result in shifts of parkers to being picked up and dropped off by private automobile and other single-party drop-off modes, which would add traffic to the terminal roadway system. In addition, political considerations may be an impediment to raising public parking rates significantly or frequently.

The approach to adjusting parking rates varies from airport to airport based on the nature of the problem the rate adjustments are intended to address, the desired change in customer behavior, and the airport operator's ability or willingness to change the parking rate structure. Examples of ways that rates may be set or adjusted to influence behavior include the following:

- Charge a higher daily rate for short-term parking compared to the daily rate for facilities designated for long-term parking. This price differential is intended to discourage long-duration parking in the short-term parking area.
- Charge a higher hourly rate in the long-term parking facility compared to the hourly parking rate in the short-term parking facility. This price differential is intended to discourage short-duration parking in the long-term parking area.
- Charge only a daily rate in the long-term parking facility and charge an hourly rate in the short-term parking facility to discourage short-duration parking in long-term parking facilities.
- Increase the differential between the daily rate in the terminal area parking facility and the daily rate in the remote

Reallocation of Valet Parking to Other Parking Products at Seattle-Tacoma International Airport

In 2007, the Port of Seattle reallocated parking spaces at Seattle-Tacoma International Airport. The reallocation has resulted in more efficient use of hourly (short-term) parking, long-term parking, premium parking, and employee parking products. Valet parking was eliminated a few months before this reallocation because it was not well utilized. The reallocation of valet parking to other uses had virtually no effect on traffic, vehicle emissions, or customer service because its elimination affected a small customer base. (*6*)

Rate Changes to Shift Passenger Demand at Miami International Airport

Parking rate changes at Miami International Airport require the approval of the Miami-Dade Aviation Department (MDAD) Board. In 2006, MDAD increased the daily rates at the airport's short-term parking facility from $25 to $30 (20%) and expanded the rate schedule for the long-term parking facility to provide a fee for the fifth hour of parking (effectively raising the daily rate from $12 to $15 [25%] with no adjustments to rates for the first 4 h of parking). These rate increases were intended to discourage long-duration parking in the short-term parking facility; however, MDAD staff does not believe the desired shift in parking behavior was achieved. Revenue increased at both facilities. (*4*)

Rate Changes to Shift Passenger Demand at Port Columbus International Airport

In 2008, the daily rate in the long-term parking garage in the terminal area at Port Columbus International Airport was increased from $15 to $17; the daily rate in the economy lots was not raised. The intent of this rate change was to shift demand from the long-term parking garage to the economy lots. Columbus Regional Airport Authority staff do not believe that this rate increase resulted in a shift in demand, but parking revenues did increase. (*11*)

Rate Changes to Shift Passenger Demand at Huntsville International Airport

The Huntsville/Madison County Airport Authority adjusted the daily rate for short-term parking at Huntsville International Airport twice to resolve a capacity constraint at the short-term (hourly) parking facility and to increase revenues generated at this facility. The daily rate for short-term parking was increased from $12 to $18 in 2004 and from $18 to $24 in 2006, while the daily rates for long-term and economy parking were increased from $8 to $9 and from $6 to $7, respectively, in 2004 and held constant in 2006. Authority staff believe that the 2004 rate change led to a small short-term shift in demand, while the 2006 rate change led to a long-term shift in demand that achieved the desired results. (*14*)

parking facility to influence some price-sensitive long-term parkers to shift to remote parking.

- Charge only a daily rate for valet parking to address a constraint in terminal area long-term facilities if the intent of valet parking is to accommodate demand for long-duration parking in a convenient terminal area location. A daily rate would discourage short-duration valet parking. The daily rate for valet parking may be set in relation to the daily terminal area parking rate and may be lower, equivalent, or higher than that rate depending on the desired behavioral change.

Differential Parking Rates

Different parking rates may be charged in the same facility to influence demand for a facility or balance demand among facilities. Differential rates may be charged to accommodate peak travel times of different customer groups or to adjust imbalanced demand between facilities. Examples could include offering a different daily rate depending on the day of the week a parking customer enters the facility, the number of days a parking customer parks in the facility, or the specific dates a parking customer parks in the facility. Implementation of this strategy requires the airport operator to have a parking revenue control system in place that is capable of processing differential rates.

Approaches to charging differential rates vary with the nature of the issue to be resolved, the desired change in behavior, and the airport operator's ability or willingness to change the parking rate structure. The best approach depends upon the goal of the airport operator (e.g., maximizing revenues versus managing the demand for parking). Examples of the implementation of differential rates for parking at an airport were

not identified in this research; however, the following examples describe how rates may be set or adjusted to influence customer behavior in addressing constrained parking:

- If the economy parking supply is constrained during weekends and terminal area parking is typically busy on weekdays and underutilized on weekends, the daily rate in the terminal area could be set to be equivalent to the daily rate for economy parking for a customer entering the terminal area facility on a Friday and departing prior to Monday morning. This approach would provide an incentive for the weekend leisure traveler to use terminal area parking, while ensuring that the price-sensitive traveler will continue to patronize economy parking on weekdays. The pricing structure in the terminal area facility would ensure that space would be preserved for the weekday customer base.
- If terminal area parking is constrained because of a high percentage of automobiles parked for a duration exceeding a certain number of days (a threshold), while a significant percentage of those automobiles are parked for a duration below the threshold, the daily rate could be adjusted to be significantly higher for durations longer than the threshold. For example, if 80% of exiting vehicles were parked for less than 3 days, and the remaining 20% were parked for 3 days or more, the daily rate may be set lower for stays of less than 3 days, and much higher for stays of 3 days or more. The daily rate for economy parking would be set in relation to the rates for terminal area parking to further encourage customers who park for 3 days or more to use economy parking.

Variable Parking Rates

Setting a variable daily parking rate schedule is similar to the yield management systems used by airlines and hotels. Under this rate scheme, airline passengers may reserve a space at a facility in advance, which may be offered at a different rate than the rate charged they if they arrived at the parking facility without a reservation. Therefore, similar to the experience of airline passengers or hotel customers, two vehicles parked side by side in the same facility may be charged different parking rates. Within a facility, parking rates may vary by length of stay, by season, and by when (i.e., how early) the customer makes a reservation for a parking space. In addition, the price differential between facilities may be dynamic. Parking rates are based on forecasts of parking demand and parking occupancy, and may be set based on experience with parking demand on various days of the week and times of the year or through a more complex parking demand forecasting effort. Parking reserved in advance would be prepaid, and may be nonrefundable or subject to a cancellation penalty.

The intent and value of charging variable parking rates in the context of constrained airport parking would be to influence parking behavior to better balance demand between parking facilities. It also would provide the airport operator with parking reservations data as a basis for estimating demand in advance of busy parking periods, and provide the airport operator with historical information as input to forecasting future demand. Implementing variable rate parking strategies requires the airport operator to have a parking revenue control system in place that is capable of processing the variable rate structure.

Curbside Drop-Off Fee

An airport operator can implement a curbside drop-off fee to enhance the effectiveness of other strategies aimed at relieving constrained parking by reducing the potential mode shift from parking to the use of curbside pickup and drop-off modes. As an example, vehicles entering Dallas/Fort Worth International Airport are charged a fee to access the airport roadways that serve the terminal curbsides and parking facilities; however, it should be noted that this fee was not implemented to address a constrained parking condition, but serves as an example of how a curbside drop-off fee could be implemented. For this strategy to be implemented effectively, an airport must be configured in a way that allows such a fee to be collected from curbside users and the regulatory environment must allow the airport operator to collect this fee.

Introduce Technology Improvements

The introduction of technology can be effective in managing constrained parking by allowing for better facility use or by providing parking customers with information about airport parking based on availability in advance of their arrival at the airport.

Automated Parking Guidance Systems

When a parking facility reaches its functional capacity (i.e., approximately 85% to 95% occupancy), airport operators typically will deploy staff to assist customers in finding parking spaces or close the facility and redirect customers to another facility to avoid excessive recirculation within the near-capacity facility and resulting customer frustration. The first alternative (assisting customers in finding parking spaces) is costly—it either adds overtime hours or draws staff away from other important duties. The second alternative (redirecting customers to another facility) results in a facility not reaching its maximum revenue potential and may still require overtime hours for management.

Parking space location technology, also referred to as automated parking guidance systems (APGS), provides customers

Variable Parking Rates at Manchester Airport, United Kingdom

Airline customers at Manchester Airport in the United Kingdom may reserve a space at a specific parking facility in advance under a variable pricing scheme, or they may pay a daily rate to park when arriving at the airport, referred to as "turn up and park." The rates offered for reserving a space in advance may be 50% lower than the turn up and park rates. The table below provides the quoted advanced-booking parking rates by facility for a weekday trip and a weekend trip in February 2010, and for a weekend trip in August 2010, as well as the turn up and park rates for those facilities where this option is available. Quotes for each trip were obtained in mid-November 2009, early December 2009, and early February 2010. The rate quoted for Multi-Storey Short Stay parking differed between the two trips in February 2010 when quoted on November 12, 2009. The Multi-Storey Short Stay, Long Stay, and Shuttle Park rates for the same trip in February differed between reservation dates. Advanced booking rates were significantly lower than the turn up and park rates for those facilities that offer the turn up and park option. (*18*)

		Parking Rate for Trip Duration				
Travel Dates	Reservation Date	Multi-Storey Short Stay (T1)	Valet (T1)	T1/3 Long Stay	T1/3 Long Stay (Early Bird)	Shuttle Park
Mon, 8 Feb 2010–Wed, 10 Feb 2010	12 Nov 2009	£29.00	£39.99	£29.99	£22.99	£23.99
	3 Dec 2009	£29.00	£39.99	£29.99	£22.99	£23.99
	3 Feb 2010	£29.99	£39.99	£23.99	n.a.	£14.99
Thu, 11 Feb 2010–Sat, 13 Feb 2010	12 Nov 2009	£35.99	£39.99	£29.99	£22.00	£23.00
	3 Dec 2009	£29.99	£39.99	£29.99	£22.00	£23.00
	3 Feb 2010	£29.99	£39.99	£23.99	n.a.	£14.99
Fri, 20 Aug 2010–Sun, 22 Aug 2010	12 Nov 2009	n.a.	n.a.	£29.99	n.a.	£14.99
	3 Dec 2009	n.a.	n.a.	£29.99	n.a.	£14.99
	3 Feb 2010	n.a.	£39.99	£29.99	n.a.	£14.99
Turn Up and Park	n.a.	£81.00	n.a.	£45.00	n.a.	n.a.
Transfer Time:		0–1 min. walk	0–2 min. walk	5–10 min. walk 10 min. shuttle	5–10 min. walk 10 min. shuttle	15 min. shuttle

Notes: Assuming that parking customer will use Terminal 1, and will enter the parking facility at 10:00 a.m. on day 1 and depart the facility at 1:00 p.m. on day 3.

T1—Terminal 1; T1/3—Terminals 1 and 3; n.a.—rate not available.

Source: https://www.manchesterairport.co.uk (as of November 12, 2009 [November 12, 2009 reservation date rates], December 3, 2009 [December 3, 2009 reservation date rates], and February 3, 2010 [February 3, 2010 reservation date rates and turn up and park rates]).

Automated Parking Guidance System at Portland International Airport

In 2008, the Port of Portland introduced a new automated parking guidance system (APGS) in its parking garage. The APGS informs customers of the number of spaces available by floor and guides parking customers to available spaces. This technology allows for a high utilization of the garage, reduces the amount of time parking customers spend looking for available parking spaces (which reduces vehicle emissions), and lessens the need for extra staff to be positioned in the garage during busy periods to assist parking customers in finding available parking spaces. (*12*)

Real-Time Parking Information at Chicago O'Hare International Airport

Real-time parking information is maintained on the website for Chicago O'Hare International Airport. The parking status summary indicates whether a parking facility is open or closed. Additionally, parking customers may subscribe to real-time parking facility status notifications sent to users' mobile devices, via e-mail, or by following a link on the parking status webpage to browse parking facility status on a mobile device. (*2*)

with information on available parking spaces by floor, by section, or by parking space, depending on the level of system sophistication. This technology allows the customer to find an available parking space in a facility that is nearing capacity more quickly than without the technology. The location technology, when provided at the highest level of sophistication, leads customers to available spaces through the use of indicators. This technology has proven to increase functional capacity to almost 100% of a parking facility without requiring additional management resources to direct customers to available parking spaces.

Real-Time Parking Information

Technology can be used to provide real-time information to parking customers regarding parking availability and allow the customers to make decisions about where to park in advance of arriving at an airport with a constrained parking facility. Information, such as parking facility closures, available spaces in a facility, or parking facility recommendations, may be obtained through the parking customer's initiative—by viewing an airport's website, calling a telephone number, listening to traveler advisory radio broadcasts, or signing up to receive messages on mobile devices or via e-mail. Information may also be provided to the parking customer via variable message signage posted along the airport access route or on airport roadways.

Promote Use of HOV Modes

An airport operator may promote the use of HOV modes, which may provide some relief in a constrained parking situation. The use of HOV modes can be promoted in a variety of ways, including disseminating information that encourages customers to use HOV modes, encouraging public transportation providers and other HOV operators to provide service enhancements and new services, or by the airport operator providing services itself.

The HOV services must be perceived as viable options for the parking customer trips to and from the airport, including the following:

- Service hours that accommodate the flight schedules of airlines serving the airport;
- Frequencies that are reasonable in relation to total travel time to the airport;
- A total trip time, from the customer's point of origin to the airport, that is not unreasonable in comparison to using a private automobile, considering that multiple stops or transfers from one HOV mode or route to another increases total travel time;
- A terminus point in reasonable proximity to the customer's origin and destination in the region, or along the customer's primary travel path to the airport via private automobile;

Promotion of High-Occupancy Vehicle Modes at Boston Logan International Airport

Since the 1980s, the Massachusetts Port Authority (Massport) has had an active airport ground access program that includes the promotion of HOV alternatives to the private automobile as a way of managing traffic and parking demand at BOS. Massport sponsors a network of four nonstop, direct express bus routes, referred to as the Logan Express, that operate between the airport and suburban locations within the BOS catchment area. Additionally, Massport partners with the public transportation provider, Massachusetts Bay Transportation Authority, in providing bus rapid transit service to downtown Boston at South Station, an intermodal transportation center. Massport also operates a free shuttle bus service that transports customers between the terminals and the airport subway station and another free shuttle bus service between the terminals and the water shuttle dock. (*1*)

- A reasonable experience with baggage storage during the trips to and from the airport; and
- Fares that are reasonable in relation to fares for other modes and that are perceived as reasonable for the service provided.

Each parking customer will have a different perception of what is reasonable. The airline passenger who is sensitive to time concerns will be less likely to switch from private automobile to an HOV mode than the airline passenger who is sensitive to price concerns. An airline passenger's choice to drive and park at an airport may indicate that the customer is accustomed to a door-to-door mode and values the convenience of driving, or does not feel that the combination of price and travel time of alternative modes is a reasonable option. This is an important consideration when the increased use of HOV modes is being evaluated as a strategy to address constrained parking.

Strategies to Respond to Short-Term Constraints

This category of strategies consists of short-term operational solutions that are intended to manage constrained parking for the duration of a specific constrained parking event. At some airports, such events may occur a few times per year, such as holiday periods and school vacations. At other airports, short-term operational strategies may be used several times per month while the airport operator may be formulating strategies to achieve longer-lasting solutions. At airports where short-term solutions are frequently used to manage parking constraints, it may be as cost-effective in the long-term to adopt some of the strategies to address ongoing parking constraints, as described in the previous section of this chapter. Additionally, several of the strategies discussed in this section could also be used from time to time to supplement the long-term strategies identified in the previous section.

General strategies considered to be short-term solutions for managing constrained public parking events include the following:

- Provide hands-on management in constrained parking facilities,
- Adjust parking rates on a temporary basis,
- Disseminate public information,
- Provide temporary overflow parking, and
- Direct parking customers to privately operated parking facilities.

Provide Hands-On Management in Constrained Parking Facilities

To maximize the use of parking facility capacity, parking staff may direct parking customers to available spaces or to another parking facility. Parking customers may be directed to areas that are typically off limits for parked automobiles, such as the end of rows if vehicle traffic will not be blocked. This approach is sometimes referred to as "stuffing and stacking."

Adjust Parking Rates on a Temporary Basis

Temporary rate changes may be used to balance demand among facilities. These rate changes may involve the following:

Temporary Rate Adjustments at Tampa International Airport

When the economy parking facilities at Tampa International Airport become constrained, the Hillsborough County Aviation Authority occasionally uses excess capacity in the short-term or long-term parking facilities, and charges the economy rates. (*7*)

Temporary Rate Adjustments at Oakland International Airport

It is rare for all public parking facilities at Oakland International Airport to reach capacity during the same period. When a facility does reach capacity, Port of Oakland staff direct parking customers to parking facilities that have excess capacity and they provide vouchers so that parking customers pay the rates they would have paid at their original parking facility of choice. For example, when the economy lot reaches capacity, parking customers may be redirected to a terminal area parking facility, but they would be charged the economy lot rate. (*10*)

Customer Service Considerations

Airport staff interviewed for this research project stressed the importance of initiating communication with airline passengers in advance of their trips to the airport during anticipated periods of constrained parking. Advance information, communicated through media such as radio announcements, general website alerts, and parking alerts via e-mail, helps airline passengers understand what to expect at the airport and to better plan for their trips to the airport.

- An advertised rate promotion offered in advance of an anticipated parking constraint to influence the parking customer's choice of parking facility; or
- A discount offered at a parking facility with available capacity when the lower priced facility is nearing capacity.

These temporary rate changes are sometimes offered as a customer service measure or to retain parkers in airport-operated facilities that may otherwise divert to privately operated off-airport parking facilities.

Disseminate Public Information

An airport operator may disseminate information to the public in advance of an anticipated constrained parking event and during the constrained parking event, using various forms of media and the airport website. Messages typically warn airline passengers of upcoming parking challenges and advise them to allow extra time for their trips to the airport. The advisories may also encourage passengers to consider using public transportation and other ground access modes to access the airport.

Provide Temporary Overflow Parking

Spaces may be made available for public parking in areas that are typically used for other purposes. For example, employee spaces may be temporarily used for public parking, or a valet lot may be temporarily used for self parking. Often, these spaces are located at a distance from the terminal area, which requires a shuttle ride between the overflow parking area and the terminal area. Furthermore, the spaces are often located in areas that are less convenient to the parking customer than public spaces in permanent service. The airport operator may or may not charge a fee for the use of overflow parking spaces. If a fee is charged, it may be equivalent to, or less than, the rate for the lowest priced parking product to acknowledge the inconvenience to the customer.

The airport operator may choose to direct all parking customers to the overflow area when a facility reaches capacity, may provide parking customers with a choice of the overflow or permanent facility before the permanent facility reaches capacity, or may direct certain customers to the overflow facility based on a travel characteristic, such as trip duration.

Direct Parking Customers to Privately Operated Parking Facilities

An airport operator may direct customers to privately operated off-airport parking facilities when the public parking supply at the airport is nearing capacity. Because the privately operated facilities may be constrained as well, the airport operator should communicate regularly with operators of the privately operated parking facilities to determine which facilities have available capacity to accommodate additional parking customers. The airport operator may negotiate a revenue sharing arrangement with the private operator for making the referral.

Employees Diverted to Overflow Parking during Periods of Constrained Parking at Seattle-Tacoma International Airport

In November 2006, during a period of constrained parking at Seattle-Tacoma International Airport, the Port of Seattle redirected approximately 500 to 600 employees who typically park in the terminal area parking garage to remote employee parking. When this strategy was implemented, it added approximately 7% to the public parking supply. Port of Seattle staff believe that this strategy was successful in preventing closures of the garage. (*6*)

Directing Parking Customers to Off-Airport Privately Operated Parking Facilities at Boston Logan International Airport

At Boston Logan International Airport, Massport occasionally directed parkers to a privately operated off-airport parking lot. Massport received $4 per automobile per day from the private operator for the referral. Because the private operator transported the airline passengers to the terminal area in its shuttle, Massport did not bear the cost of operating an additional shuttle service that would have been required to serve overflow lots. Massport discontinued diverting passengers to privately operated lots because it felt that the parking customer is provided with a better level of service if accommodated on the airport. (*1*)

Considerations for Evaluating Strategies to Resolve or Manage Constrained Parking

The financial, vehicle traffic, environmental, and customer service considerations for each strategy identified earlier in this chapter are summarized in this section by strategy. All considerations should be interpreted in the context of an airport operator's goals and objectives for its parking program.

Strategies to Respond to Ongoing Constraints

Increase Public Parking Supply

When considering an increase in the public parking supply to accommodate demand, the following financial, vehicle traffic, environmental, and customer service issues should be considered.

Financial Considerations. Financial considerations related to operating and capital costs associated with increasing the parking supply may include the following:

- Design and program management fees;
- Construction;
- Revenue control equipment;
- Staffing costs or management fees for increased staffing;
- Shuttle operations;
- Safety and security (such as new fire fighting equipment);
- Opportunity cost of the land if it has a higher and better use;
- Leasing cost if the land is owned by a third party;
- Sunk capital and temporary operating costs necessary for providing temporary replacement parking so that the permanent parking supply can be expanded;
- Sunk capital costs for permanently relocating airport facilities to expand the public parking supply; and
- Long-term reduction in operational costs to manage constrained parking, if they are reduced with the additional capacity.

Financial considerations related to cash flow and debt service associated with increasing the permanent public parking supply may include the following:

- Current debt capacity of the airport owner or operator;
- Amount of time it will take the airport operator to recover any capital investment associated with increasing capacity (return on investment);
- Differential of net parking revenues from the existing constrained parking supply and expected net revenue with the additional capacity (i.e., marginal increases in revenues resulting from increased public parking supply); and
- Estimation that the airport's debt service coverage requirements still are met after the addition of new parking capacity.

Financial considerations related to providing or expanding overflow parking facilities may include the following:

- Comparison of the net revenue per space and per event with the revenues that could be earned from the development of new permanent public spaces to determine the point at which the addition of permanent capacity or the implementation of another strategy makes better financial sense; and
- Revenue lost from customers who may choose privately operated off-airport parking options rather than the overflow facilities provided by the airport operator.

Vehicle Traffic Considerations. Considerations related to vehicle traffic generated by the airport as a result of increasing the supply of public parking may include a change in vehicle trips generated by attracting parkers lost as the result of parking constraints back to the on-airport parking supply. It should be noted that this strategy may result in a reduction in trips generated if fewer pickup, drop-off, taxicab, and single-party limousine trips are made to the airport, and an increase in trips if parkers shifted from HOV modes to the on-airport parking supply.

- Analysis to determine the projected financial performance of the airport parking supply with differential or variable rate pricing.

Vehicle Traffic Considerations. Vehicle traffic considerations related to the adjustment of parking rates may include the following:

- Changes in vehicle trips on airport roadways resulting from shifts in demand between airport parking facilities and shifts between airport-operated and privately operated off-airport parking facilities; and
- Potential changes in vehicle trips and the effects on curbside congestion resulting from shifts between airport-operated parking, privately operated off-airport parking, pickup and drop-off modes, and HOV modes.

Environmental Considerations. Environmental considerations related to the adjustment of parking rates, including regional traffic congestion and vehicle emissions, may include changes in regional vehicle emissions based on changes in vehicle trips generated by the airport resulting from passengers being attracted to, or discouraged from, using on-airport parking.

Customer Service Considerations. Customer service considerations related to the adjustment of parking rates may include the level of customer satisfaction with rate structure changes (will vary by the rate structure adopted and the effect of the rate change on level of service).

Introduce Technology Improvements

When considering the introduction of technology improvements to manage constraints, such as improving parking facility use with an automated parking guidance system or influencing airline passenger ground access behavior by providing information in advance of the airline passenger's arrival at the airport, the following financial, vehicle traffic, environmental, and customer service issues should be considered.

Financial Considerations. Financial considerations related to investments in technology improvements to manage constrained parking may include the following:

- Capital and O&M costs of technology systems;
- Comparison of the projected financial performance of the existing public parking supply with the financial performance of the projected parking supply with the implementation of technology improvements, including capital costs and changes to O&M costs, and potential shifts of parkers to or from other modes of airport access; and
- Return on investment (increased revenues versus cost of technology system[s]), including estimated changes in parking system management and staffing costs with technology versus costs to manage constrained parking.

Vehicle Traffic Considerations. Vehicle traffic considerations related to introducing technology improvements may include the following:

- Reduced travel distances and circulation time within a parking facility if technology includes parking guidance and wayfinding systems and
- Fewer parkers redirected to alternative facilities because of increased use of the existing parking supply or advanced information about parking alternatives to the constrained facility, thereby reducing traffic on airport roadways during high demand periods.

Environmental Considerations. Environmental considerations related to the introduction of technology improvements, including regional traffic congestion and vehicle emissions may include the following:

- Reduced emissions and improved air quality in parking facilities, particularly parking structures, where parking guidance and wayfinding systems are deployed; and
- Reduced emissions associated with a reduction in traffic on airport roadways resulting from reduced diversion of vehicles to alternative facilities.

Customer Service Considerations. Customer service considerations related to the introduction of technology improvements, such as parking guidance and wayfinding systems, may include and acknowledge that parking guidance and wayfinding systems are a customer service improvement in constrained parking facilities and those facilities nearing capacity because they reduce the amount of time necessary to find available parking spaces.

Customer service considerations related to the provision of real-time parking information to parking customers may include, but not be limited to the concept that parking customers may be displeased that their parking facility of choice may not be available, but the customer who accesses this information in advance will be prepared for the inconvenience, rather than reacting to it upon arrival at the constrained parking facility.

Promote Use of HOV Modes

When considering the promotion, enhancement, or provision of HOV services, the following financial, vehicle traffic, environmental, and customer service issues should be considered.

Financial Considerations. Financial considerations associated with promoting, enhancing, or providing HOV services may include the following:

- Promotional costs;
- Net financial contribution related to providing or enhancing HOV services;
- Capital costs of roadway, terminal, or curbside improvements (if applicable); and
- Lost parking revenues resulting from changes in demand for airport parking facilities.

Vehicle Traffic Considerations. Vehicle traffic considerations related to promoting, enhancing, or providing HOV services may include reduced traffic on airport roadways from those airline passengers that shift from single-party access modes, such as a private automobile, to HOV modes.

Environmental Considerations. Environmental considerations related to promoting, enhancing, or providing HOV services may include reduced regional traffic congestion and vehicle emissions based on changes in vehicle trips and VMT by airline passengers accessing the airport using the regional ground transportation system.

Customer Service Considerations. Customer service considerations related to promoting, enhancing, or providing HOV services may include the realization that if airline passengers do not perceive the value of the HOV modes, they will not use them. HOV users are more likely to become repeat users if their first experience yielded a reliable and acceptable level of service, as discussed in the description of this strategy earlier in the chapter. In that case, there is a higher likelihood that the airline passenger will choose the HOV access mode on a future trip.

Strategies to Respond to Short-Term Constraints

Provide Hands-On Management in the Constrained Parking Facilities

When considering the provision of hands-on management in a constrained parking facility to maximize use of the facility, the following financial, vehicle traffic, environmental, and customer service issues should be considered.

Financial Considerations. Financial considerations associated with the provision of hands-on management in constrained parking facilities may include increased payroll related to the deployment of additional staff to assist in directing and guiding parkers to available facilities.

Vehicle Traffic Considerations. Vehicle traffic considerations associated with the provision of hands-on management in constrained parking facilities may include the following:

- Reduced vehicle circulation within the parking facility because hands-on management assists in directing parkers to available parking spaces and
- Changes in vehicle circulation from the constrained facility to other on- and off-airport parking facilities due to hands-on management.

Environmental Considerations. Environmental considerations associated with the provision of hands-on management in constrained parking facilities may include short-term reduction in VMT and emissions resulting from reduced circulation and vehicle idling related to parkers searching for a space or being diverted to other parking facilities.

Long-term environmental impacts are not anticipated from the occasional provision of additional parking management staff during constrained conditions.

Customer Service Considerations. Customer service considerations related to the provision of hands-on management in constrained parking facilities may include the following:

- Recognition that time-constrained parking customers are less likely to miss their flights with the provision of hands-on management than are customers who spend time searching for a parking space in a constrained facility or must find another parking space in an on- or off-airport parking facility and
- Provision of hands-on management alleviates parking customers' uncertainty of finding a parking space due to a constrained parking facility.

Adjust Parking Rates on a Temporary Basis

When considering the temporary adjustment of parking rates to balance demand among facilities, the following financial, vehicle traffic, environmental, and customer service issues should be considered.

Financial Considerations. Financial considerations associated with the temporary adjustment of parking rates may include the following:

- Increased revenue from new on-airport parking customers attracted by this strategy and from parking customers who may have otherwise diverted to privately operated off-airport parking facilities,

- Decreased revenue during a constrained event if parkers used a lower-priced product than they would have if the promotion or discount were not offered,
- Advertising and promotion costs, and
- Personnel costs if additional staff are used for redirecting customers to other parking facilities with temporary rate changes.

Vehicle Traffic Considerations. Vehicle traffic considerations related to adjusting parking rates on a temporary basis during constrained periods or in advance of projected constrained periods may include the following:

- Changes in traffic patterns due to the diversion of parkers to the facility with the temporary rate change compared to customer diversion without a temporary rate change, and
- Changes in traffic when parking customers chose to use an on-airport parking facility because they were attracted to the on-airport parking supply or to a specific parking product by the temporary rate change that was advertised in advance.

Environmental Considerations. Environmental considerations related to adjusting parking rates on a temporary basis during constrained periods may include potential changes in vehicle emissions based on changes in vehicle trips and VMT related to parking customers being redirected from a constrained parking facility to another airport parking facility.

Long-term environmental impacts are not anticipated from a temporary adjustment of parking rates.

Customer Service Considerations. Customer service considerations related to the adjustment of parking rates on a temporary basis may include the realization that pricing promotions, such as comparable pricing for facilities that are in a better location compared to the constrained facility, generally are received favorably by parking customers.

Disseminate Public Information

When considering the dissemination of public information to airline passengers in advance of an anticipated constrained parking event to encourage their consideration of selecting alternative ground access modes, the following financial, vehicle traffic, environmental, and customer service issues should be considered.

Financial Considerations. Financial considerations related to implementing a public parking information program may include the following:

- Costs associated with providing and maintaining the information source, such as the dissemination of public information, including advertising and website maintenance;
- Cost of procurement, installation, and maintenance of available technology, such as variable message signage on roadways serving the airport, which directs parkers to available parking facilities;
- Reduced parking management staff costs resulting from implementation of public information strategies to reduce parking demand at constrained facilities during peak periods; and
- Potential lost revenues resulting from airline passengers electing to use an alternative mode of accessing the airport rather than driving to the airport and parking in an alternate, but available, airport parking product.

Vehicle Traffic Considerations. Vehicle traffic considerations related to disseminating information on parking constraints at the airport may include changes in the number of vehicle trips generated by airline passengers who would typically park for the duration of their trips, but may have shifted to other modes given the constrained parking environment.

Overall changes in traffic volume are not expected to be significant in most cases.

Environmental Considerations. Environmental considerations related to disseminating information on parking constraints at the airport may include temporary changes in regional airport-related vehicle emissions due to changes in vehicle trips and VMT resulting from shifts to alternative modes of airport access.

Long-term environmental impacts are not anticipated from public notification of temporary constrained parking conditions.

Customer Service Considerations. Customer service considerations related to the dissemination of public information about a parking constraint may include the realization that notifying parking customers in advance of a constrained parking event is a good customer service strategy that allows parking customers to plan their trips to the airport accordingly.

Provide Temporary Overflow Parking

When considering the provision of temporary overflow parking to accommodate demand during a constrained event, the following financial, vehicle traffic, environmental, and customer service issues should be considered.

Financial Considerations. Financial considerations related to the provision of temporary overflow parking facilities may include the following:

- Capital costs to develop, maintain, and operate the temporary facility (this strategy can be implemented for ongoing and occasional constrained parking conditions, but because

of high operational costs, it may not be effective in lieu of increasing the permanent parking supply);
- Shuttle operation costs to serve overflow facilities;
- Land available to use for overflow parking (airport operator–owned, or cost to lease or purchase if not owned by the airport operator);
- Security and lighting;
- Roadway signage and other wayfinding requirements;
- Comparison of the net revenue per space and per event to the net revenue that could be earned from permanent public spaces to determine the point at which the addition of permanent capacity, or the introduction of another strategy, demonstrates a stronger return on investment;
- Determination of whether the airport operator will charge for overflow parking and, if so, potential revenues that could be earned to offset capital and O&M costs for providing the facility; and
- Estimate of the numbers of airport parkers who may choose privately operated off-airport parking facilities (if available) instead of overflow on-airport facilities to project lost potential revenue.

Vehicle Traffic Considerations. Considerations related to vehicle traffic generated by the airport as a result of the provision of temporary overflow parking may include the following:

- Increased traffic on airport roadways if parkers are redirected to overflow parking and increased traffic from temporary shuttle bus operations,
- Reduced number of redirected automobiles if information on overflow parking is provided to parkers before they arrive at the constrained parking facility through technology or public information strategies, and
- Increased curbside congestion if overflow solutions result in parkers dropping off and picking up members of the travel party at the curbside prior to parking or after retrieving the automobile.

Environmental Considerations. Environmental considerations related to the provision of temporary overflow parking may include the following:

- Temporary changes in vehicle emissions based on changes in VMT associated with parking customers being redirected to temporary overflow parking,
- Temporary changes in vehicle emissions related to operation of shuttle bus service to a temporary overflow facility,
- Creation of additional impervious surfaces or storm water impacts if overflow facilities are developed or expanded on unpaved areas, and
- Potential FAA review and environmental approval required depending on current use of land being considered for overflow parking.

Long-term environmental impacts are not anticipated from the temporary and occasional diversion of parkers to overflow parking facilities.

Customer Service Considerations. Customer service considerations related to the provision of temporary overflow parking may include the following:

- Inconvenience to the customer compared to other strategies being considered, such as the strategy to increase the permanent parking supply; and
- Provision of information to the customer in advance of the airport trip, which is the best approach if this strategy is used.

Direct Parking Customers to Privately Operated Parking Facilities

When considering directing parking customers to privately operated parking facilities to accommodate demand, the following financial, vehicle traffic, environmental, and customer service issues should be considered.

Financial Considerations. Financial considerations related to directing parkers to privately operated off-airport parking facilities may include the following:

- Increased personnel costs to direct parking customers to privately operated facilities,
- Potential execution of a revenue sharing agreement with one or more private parking operators,
- Potential lost revenue associated with diversion of parkers to privately operated facilities compared to alternate strategies that provide the potential to generate net revenue, and
- Determination of whether diversion to privately operated facilities during occasional constrained parking conditions is preferable to investing in the provision of overflow parking or implementing other strategies to address occasional constrained parking conditions.

Vehicle Traffic Considerations. Vehicle traffic considerations related to directing parkers to privately operated off-airport parking facilities may include the following:

- Temporary increase in traffic on airport roadways because parkers are redirected to off-airport parking facilities,
- Increased curbside congestion if implementation of strategy results in parkers dropping off and picking up members of the travel party at the curbside prior to parking or after retrieving the automobile from the off-airport parking facility, and

- Long-term changes in traffic related to parkers who choose to use off-airport privately operated parking facilities in the future even when public parking at the airport is not constrained.

Environmental Considerations. Long-term environmental impacts are not anticipated from the temporary diversion of parkers to off-airport parking facilities.

Customer Service Considerations. Customer service considerations related to directing parking customers to privately operated parking facilities may include the following:

- The inconvenience to the customer compared to other strategies; when parking customers are diverted from one facility to another, some time-constrained airline passengers will miss their flights; and
- Provision of information to the airline passenger in advance of the airport trip, which is the best approach if this strategy is used.

15 travel modes, consistent with the categories in the airline passenger O&D survey. These travel modes include detailed information on private automobile use—use of the curbside only for pickup and drop-off, use of short-term parking for pickup and drop-off, or use of parking for the duration of the airline passenger's trip. The model produces an estimate of trips for the four main airline passenger customer segments—resident business, resident nonbusiness, nonresident business, and nonresident nonbusiness. It incorporates trip characteristics that influence airline passenger airport access choices, including trip duration, travel party size, number of bags checked, whether an employer is paying travel costs for a business trip, and other factors that affect mode choice decisions.

The model can be used to (1) constrain BOS public parking demand to the existing number of spaces; (2) estimate trips by mode at different parking rates; (3) estimate trips for different fares on HOV access modes; and (4) estimate the effects of changes in airport transit service, regional transit service, and the regional highway system. This information is then used to calculate estimated changes in VMT by airline-related passenger trips on local and regional roadways.

Airport employee trips are not included in the Logan Mode Choice Model. Trips generated by airport employees are estimated in the regional model; however, the regional travel demand model does not account for the unique trip patterns of airport employees. (*1*)

Airport Passenger Demand Model

In fall 2009, the Port of Portland, owner and operator of PDX, finalized an update to the airline passenger ground access travel component of the regional travel demand model referred to as the Airport Passenger Demand Model (APDM). The MPO maintains the regional travel demand model. The APDM was developed to provide the following:

- A spreadsheet model that enables the Port of Portland to test scenarios related to changes in airline passenger ground access costs, travel times, and transit availability to determine the change in trip distribution and mode choice to PDX.
- An application code that is tied to the regional travel demand model and is used to estimate the outcome of certain strategies related to parking, expansion of the regional transit system, and other measures at the regional level.

The APDM is a multinomial nested logit model that estimates trips for four airline passenger customer segments: resident business, resident personal, visitor business, and visitor personal. Trips are distributed among 11 modes, which include long-term parking in each of the three on-airport parking facilities as well as privately operated off-airport parking, and pickup or drop-off in private automobile with and without the use of short-term parking. The model was developed using approximately 2,000 responses from passenger intercept surveys collected from O&D airline passengers at PDX traveling during June and September 2008. Passenger intercept survey data indicate that resident business travelers value their travel time twice as much as residents and visitors whose travel purpose is personal. Visitors traveling for business valued their time the most—2.5 times more than resident business travelers.

Airport employee trips are not included in APDM. Trips generated by airport employees are estimated in the regional model, which does not account for the unique trip patterns of airport employees.

The Port of Portland has tested multiple scenarios with its spreadsheet model to determine how airline passenger mode choices would shift with increases in parking rates, changes in costs of other travel modes, changes in travel times, and changes in the frequency of transit services. The results, shown in Table 6, are illustrative of how the model can predict changes to assist the Port in determining the outcome of policy changes

Table 6. Portland International Airport airline passenger mode share with application of different transportation policy scenarios.

		Policy Scenario Mode Shares				
		Parking Charge Increase				
Access Mode	Existing Mode Share	10%	25%	200%	Double Travel Time	Increase Travel Time and Automobile Operating Costs by 20%, Provide Free Transit at Double the Frequency, and Double the Parking Costs
Drive and Park	34%	31%	27%	10%	37%	16%
Pickup and Drop-off	33%	36%	39%	54%	25%	44%
Taxicab, Limousine, Town Car	6%	6%	6%	7%	6%	6%
Rental Car	17%	17%	17%	17%	17%	17%
Shuttle	4%	4%	4%	4%	4%	4%
Transit	6%	6%	7%	8%	11%	13%
Total	100%	100%	100%	100%	100%	100%

Source: Port of Portland, October 2009. (*19*)

CHAPTER 6

Predicting Outcomes of Selected Strategies

A menu of strategies airport operators can implement to resolve ongoing public parking constraints or manage constrained parking events was provided in Chapter 5. Implementation of many of those strategies requires advanced planning and consideration of the impacts the strategy may have on related issues, such as parking facility use, capital or operational costs, parking-derived revenue, vehicle traffic and emissions, and customer service.

Implementation of strategies intended to resolve an ongoing public parking constraint may require capital investment and possibly executive or regulatory approval, whereas implementation of strategies to address shorter-term constrained parking events tends to involve a lower level of effort and investment. For those strategies that require more time and investment to implement, decision makers need to understand whether the strategies are likely to achieve the desired outcomes, especially within the framework of an airport operator's goals and objectives for its parking program.

The formal and informal tools and methodologies for predicting the outcome of strategies implemented to resolve ongoing constrained public parking are described in this chapter. Some of these tools and methodologies may also be useful to predict the outcome of strategies to manage short-term parking constraints.

This research project included the development and evaluation of the usefulness of a formal predictive tool (i.e., a model) to assist airport operators in understanding the magnitude of changes in parking behavior resulting from implementation of a strategy. Such a model could reveal unanticipated outcomes that would influence decision making. The consequences of a lack of understanding of the potential outcomes in advance of strategy adoption and implementation can be severe.

Formal Tools

Formal tools can be used to predict the outcomes of strategies being considered to address constrained parking. Three formal tools are discussed in this section—airport mode choice models, airport parking models, and an airport parking forecast model developed based on the research conducted for ACRP Project 10-06.

Airport Mode Choice Models

A regional organization, such as an MPO, is often responsible for regional travel demand forecasting, and may maintain a regional travel demand forecasting model. In some cases, modeling efforts my be initiated by or coordinated with an airport operator to incorporate airline passenger O&D survey data into the regional travel demand forecasting model. This airport mode choice module can provide estimates of changes in mode share and trip volumes based on various parking and transportation policy changes. Such a modeling effort requires significant input from the airport operator as the entity most familiar with the ground access travel patterns of airport customers.

Of the 15 airport operators participating in this research project, 2 have developed this type of predictive tool—the Massachusetts Port Authority for BOS and the Port of Portland for PDX. These two examples are discussed in the following sections.

Logan Mode Choice Model

The Boston Region MPO, Central Transportation Planning Staff, maintains and operates a regional travel demand model that encompasses the 101 cities and towns that form the Boston metropolitan area. This model has a nested airport mode choice model, referred to as the Logan Mode Choice Model, which is used to estimate trips generated by BOS airline passengers. This model is calibrated to airline passenger travel behavior using airline passenger O&D survey data collected every 3 years by Massport, owner and operator of BOS. The most recent calibration was completed in 2007.

The Logan Mode Choice Model is a multinomial nested logit model used to estimate access trips to BOS based on

it may introduce, and how factors and policies external to its control or authority, such as vehicle traffic congestion and transit service frequency provided to PDX by TriMet (the regional transit authority) influences airline passenger choices.

To summarize, the model results indicate that increased parking rates primarily result in shifts to pickup and drop-off modes, which double vehicle trips to PDX compared to parking for the duration of the airline passenger's trip. Increasing parking rates would reduce the demand for parking, but it would also increase vehicle traffic congestion and emissions generated by airline passenger access and egress trips. Even a tripling of parking rates would only increase the transit mode share from 6% to 8%. Increasing transit service and offering transit service free of charge, options that are not within the control of the Port of Portland, would only increase the transit mode share from 6% to 7% (this scenario is not shown in the table, but it was tested by the Port of Portland). Therefore, improving transit options as a stand-alone strategy to relieve constrained parking would not appear to be a successful strategy for managing constrained parking. (*19*)

Airport Parking Models

An airport operator also may develop its own predictive tool (i.e., a model) for parking demand or for all airline passenger modes. The model may be developed as part of the parking management program, the airport ground access program, or as part of a larger project, such as a master plan. The Port of Seattle developed such a model to predict parking behavior under a variety of scenarios that consider pricing, capacity, and other factors.

Seattle-Tacoma International Airport's Composite Parking Demand Model

In late 2008, the Port of Seattle initiated an effort to gain a better understanding of the underlying causes of fluctuations in parking demand at Seattle-Tacoma International Airport (SEA). Various multiple regression econometric models were constructed to help forecast enplanements and parking transactions in the main garage at SEA. The econometric models included independent variables, such as per capita income, population, airfare, and employment, while also taking into account seasonal variations in demand and major shifts in demand due to one-time events, such as the terrorist attacks on September 11, 2001.

The effort concluded with the development of various models to help forecast and strategize garage parking pricing, parking demand and capacity requirements, and new program implementation. By using the models, the Port of Seattle has been able to gain a better understanding of the relationship between key economic conditions and the demand for airport garage parking.

Prior to development of the models discussed here, the Port of Seattle had developed a parking choice model with price elasticity curves to analyze the parking market shares of its one public parking facility, the main garage, versus off-airport lots in the vicinity of SEA. In 2008, several analytical model steps that led into, and interfaced with, the parking choice model were added. The sequence and components of the expanded model set, referred to as the Composite Parking Demand Model, are presented below.

1. **Enplanement Model**—The Enplanement Model and its two submodels for originating and returning passengers were developed to provide an analytical tool for forecasting future volumes of these two specific groups of passengers that form the basis for demand for ground transportation access to SEA.
2. **Main Garage Demand Model**—The Main Garage Demand Model and its three submodels used to predict parking demand for weekly, daily, and hourly parking transactions were developed to provide a tool for forecasting the future parking activity of three distinct groups of parking customers driven by different sets of economic and travel considerations. This set of three submodels was also designed to support estimation of the capacity and revenue impacts in the main garage of different pricing scenarios and of fluctuations in the local economy. These submodels add to the Port of Seattle's analytical toolkit for evaluating policy options related to the main garage. Combining enplanement forecasts from the Enplanement Model with forecasts of the various factors included in the main garage submodels supports both parking transaction forecasting efforts and sensitivity analysis of the effects of future scenarios involving the sets of influential variables in the three submodel equations.
3. **Monthly Transactions and Duration Conversion Model**—The Monthly Transactions and Duration Conversion Model is a submodel of the Composite Parking Demand Model. Its purpose is to translate the parking transactions forecast information from the three main garage submodels into a detailed format conformable to the Parking Choice Model.
4. **Parking Choice Model**—This model was developed to analyze data on the main garage versus off-airport parking lot shares of overall airline passengers parking in the Seattle-Tacoma area. It includes detail on the main garage shares of the market for parking transactions of different durations, provides information on the main garage versus off-airport prices for parking transactions of different durations, and derives price response coefficients based on how much the main garage share declines for longer stays as its price premium over off-airport options becomes greater. Originally calibrated for 2006–2007 transactions, the Parking Choice Model is structured so that alternative transaction data, such as that produced by the Monthly Transactions and Duration

Conversion Model, can be input. By explicitly including variables for off-airport parking prices, the model also allows the user to examine the composite effects of alternative pricing scenarios, such as main garage pricing changes that are mirrored by off-airport lot pricing reactions, or main garage pricing changes alone. (*20*)

ACRP Project 10-06 Airport Parking Forecast Model

A model for testing resident airline passenger mode-share behavior was developed for ACRP Project 10-06 to provide analysts with a tool for predicting, at a high level, likely outcomes of strategies being considered to address constrained airport parking. The model, referred to as the General Airport Parking Forecast Model, was developed based on data collected at 14 U.S. airports. An airport-specific version of the model was also developed based on data collected at PDX, which was among the 14 airports used for data collection. These two versions of the model were developed to provide airport operators and others with information regarding the benefits and tradeoffs of developing their own airport-specific models versus using the general airport model. The research team evaluated the effectiveness of the models by comparing projected results of identical policy scenarios for PDX from the airport-specific model and the general airport model, and found both to be effective for estimating the results of policy scenarios, as described in the rest of this section.

The general airport model was developed as a tool for any commercial airport operator to use to estimate results at its airport without undergoing an extensive data collection effort. The model can be used to compare results between scenarios for a specific airport. It calculates the results using the underlying survey data from the 14 U.S. airports and the characteristics of the available modes and resident airline passenger mode shares for the specific airport that would be added to the inputs page by the analyst. The general airport model and instructions on how to use it are available on the CD-ROM that accompanies this report.

In comparison to the general airport model, an airport-specific model will produce estimated results with a higher level of accuracy for the airport, may include more mode options that are specific to the airport, and can be structured to test more strategies and strategies that are more relevant to the specific airport environment. Such a model requires an investment of time and money by the airport operator, including the collection of survey information for model development.

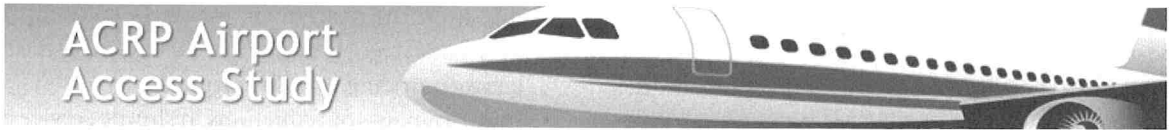
The airports included in this research have experienced constrained parking conditions within the past 10 years. The airport-specific model is based on data collected at PDX. The general airport model is based on data collected at the following airports:

- Boston Logan International Airport (BOS),
- Chicago O'Hare International Airport (ORD),
- Huntsville International Airport (HSV),
- McCarran International Airport (LAS),
- Miami International Airport (MIA),
- Oakland International Airport (OAK),
- Port Columbus International Airport (CMH),
- Portland International Airport (PDX),
- San Antonio International Airport (SAT),
- San Diego International Airport (SAN),
- Seattle-Tacoma International Airport (SEA),
- Tampa International Airport (TPA),
- Tulsa International Airport (TUL), and
- Washington Dulles International Airport (IAD).

To provide reliable results for the airport-specific model, the sample size of the data collected at PDX was larger than the sample sizes collected at the other 13 airports for the General Airport Parking Forecast Model. The PDX sample was weighted for inclusion in the general airport model so it would not skew the results of the general model.

The models were developed in Microsoft Excel and offer user-friendly interfaces. They are multinomial logit models based on data collected in an online stated preference survey of airline passengers at each of the sample airports, conducted between April 21, 2009 and May 4, 2009. Stated preference survey data are useful in estimating cause–effect relationships for airport access. A stated preference survey is designed to collect much of the information obtained in an O&D survey that is necessary to understand the respondent's ground access behavior on a previous trip (referred to as "revealed preference" data), including mode, trip purpose, trip origin, travel party size, length of stay, and other relevant information, as well as data on future ground access choices airline passengers would make under different policy scenarios, referred to as "stated preference" experiments. Stated preference experiments were used to test the effects on airport choice and parking behavior of a wide range of variables that are likely to influence decisions on whether or not to use airport parking, including location, price, availability, shuttle service quality and availability, and availability and level of service of alternative HOV options to access the airport. An example of a stated preference experiment from the survey is shown in Figure 2. The methodology used for collecting the stated preference survey data, as well as the survey instrument, are provided in the Final Report for ACRP Project 10-06.

A discussion of both the general airport and airport-specific parking forecast models is provided in the following sections. The level of reliability and results of the general airport model also are discussed. To achieve more detailed results, airport operators may consider developing a model specific to their airport conditions and characteristics, so a comparison of the



Which option would you choose for traveling to Boston Logan Airport for a business trip?

Take Shared Ride Van	Dropped Off by Taxi	Drive and Walk from Parking	Drive and Take Shuttle from Parking
Travel time to airport: **58 mins.**	Travel time to airport: 45 mins.	Travel time to airport: 45 mins.	Travel time to airport: 45 mins.
One-way fare to airport: **$17.50** per person	One-way taxi fare to airport: **$14.00**	Daily parking fee: **$25.00**	Daily parking fee: **$12.50**
		Walking distance to terminal	Wait for airport shuttle to terminal: **5 minutes**
			Ride airport shuttle to terminal: **8 minutes**
Dropped off at terminal	Dropped off at terminal	Drive around looking for parking spot: **10 minutes**	Drive around looking for parking spot: **10 minutes**
○ I'll take a shared ride van	○ I'll get dropped off by taxi	○ I'll drive and walk from parking	○ I'll drive and take a shuttle from parking

Question **1** of 8

Next Question

Source: Resource Systems Group, Inc., 2009.

Figure 2. Example of a stated preference experiment from ACRP Project 10-06 Stated Preference Survey.

two models and a discussion of approaches for estimating the effects of strategy implementation from the model results also are provided.

General Airport Parking Forecast Model

The General Airport Parking Forecast Model captures the difference between large-hub airports and small- or medium-hub airports and can be used to test strategies at any small-, medium-, or large-hub airport. The model provides planning-level insight into potential airport operator and other transportation agency policies to address constrained parking. As such, it is a useful tool for airport policymakers to use in evaluating a range of potential strategies being considered by reviewing the relative changes in mode shares for each strategy tested.

Examples of strategies that may be tested with the model include changes in parking rates, changes in the level of service of remote parking shuttles, changes in the level of service or fares for HOV modes, the introduction of transit at airports that do not offer transit, the addition of remote parking capacity, and a drop-off fee for private automobiles transporting passengers in the pickup and drop-off mode. The model does not allow the user to test the relationship between the use of parking owned by the airport operator and privately operated parking. Privately operated parking is included as part of the mode category for park and ride shuttle to terminal. The model also does not have the capability to account for the severity of the parking constraint at an airport. The Final Report for ACRP Project 10-06 provides recommendations for future enhancements to the model to address these limitations.

The research team used industry standard modeling methods to determine model segments and coefficients that best fit the stated preference data set. During model estimation, it was observed that behavioral differences existed between business and nonbusiness trips that could be captured by using separate choice models. The two separate choice models were incorporated into the General Airport Parking Forecast Model. From this, the Excel-based forecast model was created by calculating the probability of using an access mode for a specific scenario and by applying the probability to the sample to calculate respondent-level preferences for each access mode.

Using the General Airport Parking Forecast Model. The general airport model, created in Microsoft Excel 2007, is available on the CD-ROM that accompanies this report. Model inputs include base case resident airline passenger mode-share distribution data for resident airline passengers traveling for business and nonbusiness purposes, and travel times and rates for parking and other modes, as shown in Table 7. The travel time pricing inputs are also shown in Table 8. The most accurate source for resident airline passenger mode-share data is a survey of O&D airline passengers, as described in Chapter 8.

Step-by-step instructions for testing strategies for alleviating constrained public parking in the general airport model are as follows:

1. Enter base case mode share for resident business and resident nonbusiness passengers into base case ground access mode shares cells. If the mode shares for resident business and resident nonbusiness passengers are unknown, the mode share for resident airline passengers can be entered into both sets of cells. As noted previously, the model does not distinguish between privately operated off-airport parking and remote public parking. Both categories are included in "park and ride shuttle to terminal."
2. Enter the proportion of business and nonbusiness resident airline passengers in the base case column.
3. Enter actual or estimated base data for pricing and travel times into the base case column.
4. Enter pricing and travel times appropriate for the strategy being considered.
5. Click the cursor on "calibrate to base case" button. Instructions for how to set macro permissions in Excel for optimum use of the model are included in model documentation.
6. The mode-share distribution will be shown in the model output section of the user interface page. Table 9 presents an example of results from the model output tables.

Application of the General Airport Model. The General Airport Parking Forecast Model can be used to compare the relative effects of many different strategies being considered. Strategies may be tested individually or together. To understand the effect of each strategy, the strategies should be evaluated individually before considering the adoption and implementation of a combination of strategies. Common examples of strategies an airport operator may consider include the following:

- Parking rate changes at different parking facilities (the model allows the user to test parking rate changes for the parking supply within walking distance of the terminal and the remote parking supply, but does not distinguish parking beyond these two categories; rate changes may include absolute dollar increases for terminal area and remote parking, uniform percentage increases to each, increases in only one category, or changes that examine the relationship between pricing in each category);
- Improvements or reductions in shuttle service between the terminal and remote parking facilities, which include the frequency to the terminal or wait times;
- Improvement or degradation in the travel times of other modes in relation to automobile travel time; and
- Changes in passenger fares for modes that are alternatives to driving and parking, including instituting a drop-off fee for automobiles transporting airline passengers for pickup and drop-off at the curbside.

Three example policy scenarios were tested in the general airport model. The example policy scenarios, along with an interpretation of the model results, include the following:

- **General Airport Model Scenario No. 1: Doubling of Parking Fees**—One of the key strategies an airport operator will consider to try to influence parking mode share is to change parking rates. In the scenario shown in Table 10, a doubling of the parking fees at a hypothetical small-hub airport is tested. Although airport operators do not frequently double the fees for public parking, the example illustrates how a dramatic change in parking fees would affect travel behavior. For purposes of this example, doubling parking fees is representative of constraining parking because this dramatic increase in parking fees is likely to influence passenger perspective of the availability of parking. In this scenario, 16% of total airline passengers accessing the airport (accounting for 40% of the passengers that would have parked for the duration of their trips) shifted primarily to the drop-off mode (11%), followed by the taxicab mode (2%). This analysis illustrates the relationship between parking constraints and shifts to drop-off modes.
- **General Airport Model Scenario No. 2: Reduction of Parking Fees**—A second scenario was tested to measure the influence that a 50% reduction of parking fees would have on passenger ground access behavior at a large-hub airport. This scenario, shown in Table 11, is presented to demonstrate the relationship between changes in perceived parking constraints (or, in this case, reduced constraints) and ground access mode-share distribution. In this scenario, the airport has a significant transit mode-share of 15%; however, this mode share was minimally affected by the policy to influence passenger parking behavior. The shift in mode share occurred from drop-off modes (private automobile and taxicab) to the use of parking facilities.
- **General Airport Model Scenario No. 3: Addition of Parking**—The presence of off-airport parking has a meaningful effect on an airport's ground access mode-share distribution. Although the stated preference survey did not distinguish between on-airport parking that required a

Table 7. Model inputs for the General Airport Parking Forecast Model.

Airport Specific Base Case & Policy Scenario Levels	Base Case	Policy Scenario	Units
Park & Walk to Terminal Parking Fee	$25.00	$35.00	per day
Park & Ride Parking Shuttle to Terminal Parking Fee	$18.00	$20.00	per day
Parking Shuttle Riding Time to Terminal	10	10	minutes
Wait Time for Shuttle	10	5	minutes
Airport Drop Off Charge	N/A	$0.00	$/trip
Taxi/Limo/Towncar Fare by Distance	$2.00	$2.50	$/mile
Transit Fare	$3.00	$3.50	$/trip
Shared Van Fare by Distance	$1.75	$2.00	$/mile
Scheduled Bus Fare by Distance	$0.20	$0.20	$/mile
Additional Transit Time (over auto travel time)	0.30	0.30	mins/mile
Additional Shared Van Time (over auto travel time)	0.30	0.30	mins/mile
Additional Bus Time (over auto travel time)	0.30	0.30	mins/mile
Amount of Remote Parking	1.00	1.20	(1,000s of spaces)

Alternative Availability	Base Case	Policy Scenario
Park & Walk to Terminal	TRUE	TRUE
Park & Ride Shuttle to Terminal	TRUE	TRUE
Taxi/Limo/Towncar to Terminal	TRUE	TRUE
Dropped Off at Terminal	TRUE	TRUE
Transit to Airport	TRUE	TRUE
Shared Van to Airport	TRUE	TRUE
Scheduled Bus to Airport	TRUE	TRUE

Resident Air Passengers Trip Purpose	Base Case
Business Trips	29%
Non-Business Trips	71%

Airport Size	Small/Medium Hub

Base Case Ground Access Mode Shares	Business Trips
Park & Walk to Terminal	32%
Park & Ride Shuttle to Terminal	17%
Taxi/Limo/Towncar to Terminal	17%
Dropped Off at Terminal	14%
Transit to Airport	10%
Shared Van to Airport	9%
Scheduled Bus to Airport	1%
Total	100%

Base Case Ground Access Mode Shares	Nonbusiness Trips
Park & Walk to Terminal	13%
Park & Ride Shuttle to Terminal	18%
Taxi/Limo/Towncar to Terminal	9%
Dropped Off at Terminal	32%
Transit to Airport	18%
Shared Van to Airport	7%
Scheduled Bus to Airport	3%
Total	100%

Source: Resource Systems Group, Inc., November 2009.

Table 8. Pricing and travel time model inputs, General Airport Parking Forecast Model (base case).

Model Input	Units
Park and Walk to Terminal Parking Fee	Per day
Park and Ride Shuttle to Terminal Parking Fee	Per day
Shuttle Riding Time to Terminal	Minutes
Wait Time for Shuttle	Minutes
Airport Drop-Off Charge[1]	$ per trip
Taxi Fare by Distance	$ per mile
Transit Fare	$ per trip
Van Fare by Distance	$ per mile
Scheduled Bus Fare by Distance	$ per mile
Additional Transit Time (over automobile travel time)	Minutes per mile
Additional Van Time (over automobile travel time)	Minutes per mile
Additional Bus Time (over automobile travel time)	Minutes per mile
Amount of Off-Airport Parking	Spaces (in thousands)

Note:

[1] The drop-off fee is a per trip fee charged to all passengers dropped off by private automobile at the terminal.

Source: Resource Systems Group, Inc., August 2009.

Table 9. Example of output from the General Airport Parking Forecast Model.

	Business Trips			
Resident Access Mode Share	Base Case	Policy Scenario	Absolute Difference	% Difference
Park & Walk to Terminal	32%	23%	-9%	-30%
Park & Ride Shuttle to Terminal	17%	23%	6%	35%
Taxi/Limo/Towncar to Terminal	17%	14%	-3%	-17%
Dropped Off at Terminal	14%	19%	5%	35%
Transit to Airport	10%	11%	1%	14%
Shared Van to Airport	9%	9%	0%	-1%
Scheduled Bus to Airport	1%	1%	0%	38%
Total	100%	100%		

	Nonbusiness Trips			
Resident Access Mode Share	Base Case	Policy Scenario	Absolute Difference	% Difference
Park & Walk to Terminal	13%	9%	-4%	-35%
Park & Ride Shuttle to Terminal	18%	19%	1%	5%
Taxi/Limo/Towncar to Terminal	9%	7%	-2%	-21%
Dropped Off at Terminal	32%	37%	5%	15%
Transit to Airport	18%	19%	1%	4%
Shared Van to Airport	7%	7%	0%	-7%
Scheduled Bus to Airport	3%	4%	1%	17%
Total	100%	100%		

	All Trips			
Resident Access Mode Share	Base Case	Policy Scenario	Absolute Difference	% Difference
Park & Walk to Terminal	19%	13%	-6%	-32%
Park & Ride Shuttle to Terminal	18%	20%	2%	13%
Taxi/Limo/Towncar to Terminal	11%	9%	-2%	-20%
Dropped Off at Terminal	27%	32%	5%	18%
Transit to Airport	16%	17%	1%	6%
Shared Van to Airport	8%	7%	0%	-5%
Scheduled Bus to Airport	2%	3%	0%	19%
Total	100%	100%		

Source: Resource Systems Group, Inc. 2009.

Table 10. Doubling of parking fees at a small-hub airport.

	All Trips			
Access Mode Share	Base Case	Policy Scenario[1]	Absolute Difference	Percent Difference[2]
Park and Walk to Terminal	15%	6%	-9%	-57%
Park and Ride Shuttle to Terminal	25%	18%	-7%	-27%
Taxicab to Terminal	10%	12%	+2%	+22%
Dropped Off at Terminal	40%	51%	+11%	+27%
Transit to Airport	1%	1%	0%	+21%
Shared Van to Airport	4%	5%	+1%	+22%
Scheduled Bus to Airport	5%	6%	+1%	+27%
Total[3]	100%	100%		

Notes:

[1] Although this scenario is representative of conditions at a small-hub airport, which is less likely to be well served by public transit compared to large-hub airports, the stated preference survey experiments did include public transit options.

[2] Percent difference calculations may differ due to rounding.

[3] Totals may not add to 100% due to rounding.

shuttle bus to access the terminal and privately operated off-airport parking, a scenario was tested in the constrained parking forecast model in which 5,000 remote spaces (correlated to the "park and ride shuttle to terminal" mode) were added to the public parking supply. This scenario applies to the addition of 5,000 spaces to either the on-airport public remote parking supply or the off-airport privately operated parking supply. Table 12 presents the results of this scenario. The addition of remote parking shifts mode share mainly from the "park and walk to terminal" and "dropped of at terminal" modes to the "park and ride shuttle to terminal" mode. This result implies that the addition of parking capacity does not generate significant demand for parking, as the overall share of passengers parking increased only two percentage points despite a significant increase in parking supply. In this circumstance, with the majority of the mode shift coming from the "park and walk to terminal" mode and the "dropped off at terminal" mode, vehicle trips to the airport and in the terminal area will decrease because, for every one-way airline passenger trip, passengers who are dropped off generate two vehicle trips and passengers who park for the duration of their trips only generate one vehicle trip. However, revenue implications to the airport operator also would need to be considered.

As demonstrated in the example scenarios, the General Airport Parking Forecast Model can be used to test a variety of changes (price and travel time) related to the provision of airport access modes that could be used to address constrained parking conditions. The estimates from this model represent averages from the 14 airports surveyed and airport-to-airport differences may not be fully represented when the model is applied to a specific airport.

The General Airport Parking Forecast Model reasonably represents the general magnitudes of changes in airline passenger access mode choices, even for those airports that do not

Table 11. Reduction of parking fees by 50 percent at a large-hub airport.

	All Trips			
Access Mode Share	Base Case	Policy Scenario	Absolute Difference	Percent Difference[1]
Park and Walk to Terminal	5%	11%	+6%	+117%
Park and Ride Shuttle to Terminal	10%	15%	+5%	+48%
Taxicab to Terminal	30%	27%	-3%	-10%
Dropped Off at Terminal	30%	24%	-6%	-19%
Transit to Airport	15%	15%	0%	-3%
Shared Van to Airport	5%	4%	-1%	-11%
Scheduled Bus to Airport	5%	4%	-1%	-19%
Total[2]	100%	100%		

Notes:

[1] Percent difference calculations may differ due to rounding.

[2] Totals may not add to 100% due to rounding.

Source: Resource Systems Group, Inc., August 2009.

Table 12. Addition of remote parking supply at a large-hub airport.

	All Trips			
Access Mode Share	Base Case	Policy Scenario	Absolute Difference	Percent Difference[1]
Park and Walk to Terminal	5%	4%	-1%	-25%
Park and Ride Shuttle to Terminal	10%	13%	+3%	30%
Taxicab to Terminal	30%	30%	0%	-2%
Dropped Off at Terminal	30%	29%	-1%	-3%
Transit to Airport	15%	15%	0%	0%
Shared Van to Airport	5%	5%	0%	-2%
Scheduled Bus to Airport	5%	5%	0%	-3%
Total[2]	100%	100%		

Notes:

[1] Percent difference calculations may differ due to rounding.

[2] Totals may not add to 100% due to rounding.

Source: Resource Systems Group, Inc., August 2009.

have highly accurate access mode-share information available, and should prove useful as a planning-level model for any airport with constrained parking. When the General Airport Parking Forecast Model is used and calibrated to the base access mode shares for the airport under study, the results should be interpreted as accurately representing relative changes when comparing pricing and other policies. For example, the differences in the mode-share distribution that results from a 10% increase in terminal parking prices compared to those that result from a 20% increase in terminal parking prices should be accurately represented (e.g., within 15% or so, based on variations in behavior among airports as observed in the models developed for this research project), as well as the differences in mode-share distribution that result from the scenarios presented in the example scenarios. However, the actual mode shares that result from pricing or policy changes may differ from the model-estimated shares because of differences in behavior among airports that are not represented in the general airport model.

An airport's specific characteristics could be represented in more detail and provide a higher level of predictive accuracy if an airport-specific survey and model were developed, as described in the next section.

Airport-Specific Parking Forecast Model

An airport-specific parking forecast model is a customized model that represents the environment of a specific airport, thereby increasing the model's overall utility. In comparison to the General Airport Parking Forecast Model, a model developed specifically for one airport may include more mode options that are specific to that airport and could be structured to test more strategies and strategies that are more relevant to that specific airport environment. The airport-specific model may also include additional calculations of outcomes related to strategies that have the potential to resolve constrained airport parking, such as gross parking-derived revenues and the likely changes in the number of vehicle trips generated by airline passengers.

An airport-specific parking forecast model was developed for PDX as part of this research project. The model included access modes, pricing, and time variables specific to PDX. As part of the sampling plan, a larger number of responses was collected from the PDX catchment area than was collected in the sample from each airport for the General Airport Parking Forecast Model. This larger sample from a single airport allowed for the development of a model specific to circumstances at PDX.

PDX was selected because (1) the Port of Portland has dealt with policy-related constrained parking conditions since 2003, (2) a light rail line to PDX opened in 2001, and (3) the public parking supply at PDX is supplemented by a privately operated off-airport parking supply. In addition, the Port of Portland was one of two airport operators participating in this research project that had the potential to field-test results and compare them to similar results from their own predictive tools.

The model was developed using a similar methodology as described for the General Airport Parking Forecast Model, except that separate modules were not developed for business and nonbusiness passengers.

The draft PDX parking model was field tested by a Port representative to obtain feedback on the model with respect to its ease of use and applicability of results. The model was received favorably, except for a preference to segment the mode-share distribution by business and nonbusiness travelers. It was noted that the results for strategies tested were similar to the results from the PDX Air Passenger Demand Model.

Value of Airport-Specific Parking Forecast Model

Development of an airport-specific parking forecast model will most likely require new data collection and model development by the airport operator or another interested party,

which would take several months to complete and additional commitment and investment by the airport operator. Since this is a specialized area, development of an airport-specific model requires specialized expertise. The decision to commission a new airport-specific model versus using the General Airport Parking Forecast Model will be based on the need to obtain results with a higher level of accuracy, with specificity to the airport, or with details not included in the General Airport Parking Forecast Model. The Final Report for ACRP Project 10-06 includes recommendations for data collection and enhancements to the model based on the research that the airport operator should consider when choosing between the General Airport Parking Forecast Model and development of an airport-specific model.

One measure of the usefulness of the airport-specific parking forecast model is the assessment by the Port of Portland representative that the model results were similar to the results of the PDX Air Passenger Demand Model developed by the Port of Portland in 2009.

Comparison of Airport-Specific and General Airport Models

A comparison of the results of the airport-specific parking forecast model and the results of the General Airport Parking Forecast Model provides some insight into the value of developing an airport-specific parking forecast model. To evaluate the usefulness of the airport-specific model versus the general airport model, the results from each model with identical policy scenarios applied to the PDX environment were compared. Both models were calibrated to the specific characteristics of PDX.

Two scenarios were developed to compare the results of the airport-specific and general airport models based on the specific characteristics of PDX. Scenario No. 1 tested a 50% increase in parking fees—from $30 to $45 for the "park and walk to terminal" mode and from $8 to $12 for the "park and ride shuttle to terminal" mode. Scenario No. 2 tested implementation of a $10 drop-off fee at curbside. Tables 13 and 14 present the results from both the airport-specific model and the general airport model. In reviewing these results, the differences should be considered rather than the mode-share distributions.

In the first scenario, the general airport model produces results that are similar to the PDX model. In the second scenario, the share of customers dropped off at the terminal (the customers who would be affected by this policy change) differs by 4 percentage points, which could indicate that customers in the 14-airport sample are generally less price sensitive than PDX customers or that they have fewer HOV options. More policies would have to be tested to compare differences in order to determine whether or not an airport operator should consider developing its own model or use the general airport model to test policy scenarios.

Using Model Results to Estimate Impacts of Strategy Implementation

Potential enhancements to the general airport model that would increase its usefulness in estimating the effects of constrained airport parking include the addition of calculations of parking transaction parking revenue, vehicle trips generated by airline passengers, and related changes to vehicle emissions.

The mode-share input and output from the general airport model can be used to estimate, at a high level, changes in vehicle trips and emissions by airline resident O&D passengers. The methodology described in Chapter 8 under "Measuring Effects of Parking Strategies" (in subsections on vehicle traffic

Table 13. Comparison of general airport and airport-specific models with 50-percent increase in parking fees.

	Portland International Airport Mode Share			
		Policy Scenario		
Access Mode Share	Representative Base Case	General Airport Model	Airport-Specific Model	Policy Scenario Difference[1]
Park and Walk to Terminal	10%	5%	4%	1%
Park and Ride Shuttle to Terminal	15%	13%	12%	1%
Taxicab to Terminal	10%	11%	11%	0%
Dropped Off at Terminal	45%	50%	51%	1%
Transit to Airport	10%	10%	11%	1%
Shared Van to Airport	5%	5%	5%	0%
Scheduled Bus to Airport	5%	6%	6%	1%
Total	100%	100%	100%	

Note:

[1] Policy scenario difference calculations may differ due to rounding.

Source: Resource Systems Group, Inc., August 2009.

Table 14. Comparison of general airport and airport-specific models with implementing a $10 drop-off fee.

	Portland International Airport Mode Share			
		Policy Scenario		
Access Mode Share	Representative Base Case	General Airport Model	Airport-Specific Model	Policy Scenario Difference
Park and Walk to Terminal	10%	12%	13%	1%
Park and Ride Shuttle to Terminal	15%	19%	20%	1%
Taxicab to Terminal	10%	12%	12%	0%
Dropped Off at Terminal	45%	35%	31%	4%
Transit to Airport	10%	11%	12%	1%
Shared Van to Airport	5%	6%	6%	0%
Scheduled Bus to Airport	5%	6%	7%	1%
Total	100%	100%	100%	

Note: Totals may not add to 100% due to rounding.

Source: Resource Systems Group, Inc., August 2009.

volume and emissions) can be used to determine the changes from implementing a strategy, as long as the other input data are available (such as vehicle occupancy by mode). However, some of the strategies may result in a change in the vehicle occupancy rate by mode, which is not predicted by the model. Parking facility exits (transactions) can be estimated for the two parking mode categories (i.e., "park and walk to terminal" and "parking and ride shuttle to terminal"), since exits are equivalent to private automobile trips in each category, with the qualification that a change in the vehicle occupancy rate by mode will influence the number of parking exits. It is not recommended that an airport operator use the model to estimate parking revenue because the model allows for only two parking categories (meaning two rates) and does not consider the average length of stay for parking customers (meaning that it does not consider changes to the average length of stay resulting from different strategies). Some strategies will result in a change in the length of stay distribution by facility, which will affect revenues received.

Informal Tools

An airport operator may also use informal tools to estimate the effects of strategies being considered to address constrained airport parking. One approach is scenario analysis, which is the process of predicting, analyzing, and preparing for a range of effects associated with implementation of a variety of strategies to address constrained parking. The effects evaluated will be based on the airport operator's goals and objectives related to the parking program. Based on estimates of changes in parking behavior at varying levels, effects evaluated may include revenues, vehicle trips generated by airline O&D passengers, and changes in vehicle emissions. The analysis may be based on experience, operational intuition, or benchmarks obtained from airports with similar operating environments and experience. An example of a scenario analysis used to evaluate a strategy to address constrained parking would be estimating demand and revenue at different parking rates.

Formal tools allow the user to look at a variety of outcomes related to passenger parking behavior and overall mode-share distribution, which is in many cases based on relationships established from underlying data. The user can compare strategies and understand the differences in outcomes at a certain level of reliability. The analysis results also may reveal outcomes that were unanticipated by the user. Informal tools are not as useful in comparing strategies because it is difficult to compare a range of potential results. In addition, changes in mode share will not be possible to predict because the relationships between mode preferences would not have been established.

Benchmarks with the results from other airports also may provide some insights into the reasons for parking constraints and strategies that may relieve constraints and for making generalized comparisons with other airports. However, a wide range of variability typically can be found in these ratio-based benchmarks given the unique characteristics of each airport. Differing characteristics that may influence the ratio-based benchmarks include the percentage of airline passengers parking at an airport, the strength and availability of privately operated off-airport parking, and, most importantly, whether the existing parking supply is adequate or is currently constrained, among other factors. Therefore, when airport operators consider which airports to benchmark, they should consider those with similar characteristics and benchmark against some with constrained parking and some without constrained parking. Benchmarks related to parking supply include the following:

- **Public parking spaces per O&D passenger**—Because the majority of parking activity is generated by resident airline passengers, the ratio of parking spaces available per resident O&D passenger is a meaningful benchmark that attempts

Table 15. Comparison of rates: relationship of daily parking rates to rates for other parking products.

Airport	Hub Classification[1]	Daily Parking Rate (Long-Term or Daily Parking Facility)	Comparison to Daily Rates of Other Parking Products		
			Short-Term or Hourly Parking	Valet Parking	Economy Parking
Boston Logan International (BOS)	Large	$24	–	–	75%
Chicago O'Hare International (ORD)	Large	$30	167%	150%	30%–53%
McCarran International (LAS)	Large	$14	–	150%	57%
Miami International (MIA)	Large	$15	200%	200%	53%
San Diego International (SAN)	Large	$21	124%	143%	48%–76%
Seattle-Tacoma International (SEA)	Large	$26	135%	–	–
Tampa International (TPA)	Large	$15	133%	167%	60%
Washington Dulles International (IAD)	Large	$17	212%	112%	59%
Bob Hope (BUR)	Medium	$20	150%	100%	45%–55%
Oakland International (OAK)	Medium	$22	145%	177%	68%
Port Columbus International (CMH)	Medium	$17	159%	118%	35%–53%
Portland International (PDX)	Medium	$14	171%	214%	57%
San Antonio International (SAT)	Medium	$10	220%	–	60%
Huntsville International (HSV)	Small	$8	150%	–	75%
Tulsa International (TUL)	Small	$10	100%	180%	60%

Notes:

– means data are not applicable.

[1] Hub size is defined by the FAA for commercial service airports based on the community's share of total U.S. passenger boardings accommodated. Large-hub airports accommodate 1% or more of annual passenger boardings; medium-hub airports accommodate at least 0.25%, but less than 1% of passenger boardings; and small-hub airports accommodate at least 0.05%, but less than 0.25% of passenger boardings in the United States and its territorial possessions.

Source: Ricondo & Associates, Inc. and DMR Consulting, based on airport case studies and representing conditions for different time periods (case studies collected from November 2008 through February 2009). (*1–15*)

to normalize the parking supply to potential customers. This information can be used to consider the supply needed in the future compared to forecast growth in number of airline passengers. Other public parking ratios that may be considered for different purposes include (1) airport-operated spaces per O&D passenger, (2) airport-operated spaces per resident O&D passenger, (3) total public parking spaces (airport operated plus privately operated) per O&D passenger, and (4) total public parking spaces (airport operated plus privately operated) per resident O&D passenger.

- **Composition of parking supply**—Types of parking by O&D passenger or resident O&D passenger, or the percentage of supply of a variety of parking products, such as long-term parking, short-term parking, or satellite parking, may provide insight.
- **Relationship between rates**—The relationship between rates for different parking products may assist airport operators in adopting rates that are different from rate changes made in the past.
- **Mode share**—The nature of the airline passenger customer base, as well as the viable modes available to airline passengers based on service area, levels of service, and prices in relation to other modes will all influence the mode-share distribution at an airport. There may be value in comparing the airport's mode share to mode shares at similar airports, but it is likely that the comparison will have less value than the other benchmarks listed.

Table 15 presents a comparison of daily parking rates to other parking rates at the airports included in ACRP Project 10-06.

CHAPTER 7

Guidelines for Strategy Selection

This chapter provides guidance on selecting strategies to manage or resolve constrained airport public or employee parking conditions. An approach for filtering, selecting, and evaluating strategies is presented and followed by examples.

Strategy Selection Approach

A step-by-step approach that airport operators and others can follow to select strategies to manage or resolve constrained airport parking is presented in this section. The approach consists of three phases:

- **Initial filtering phase**—A qualitative evaluation of strategies to eliminate strategies from further consideration;
- **Alternatives analysis phase**—A rigorous, analytic evaluation of strategies; and
- **Comparative analysis phase**—A comparison of viable alternatives to identify the best solution for the airport operator.

In Chapter 3, the development of goals and objectives for the provision and management of an airport parking program was described in the context of the airport operator's guiding principles for operating and managing an airport. These goals and objectives for the parking program serve as the framework for filtering and selecting strategies to manage or resolve constrained parking and for evaluating the performance of the strategies once adopted. For purposes of this discussion, it is assumed that the airport operator has developed goals and objectives for its parking program. If it has not, the guiding principles and other influencing factors described in Chapter 3 should be used as the framework for selecting the preferred strategy or combination of strategies.

Initial Filtering Phase

Multiple strategies may have the potential to resolve or help manage parking constraints at a particular airport; however, some may not be plausible based on the circumstances at the airport, the desired timeframe for achieving results, and the goals and objectives for the parking program. The purpose of the initial filtering phase is to qualitatively evaluate and eliminate strategies from further consideration.

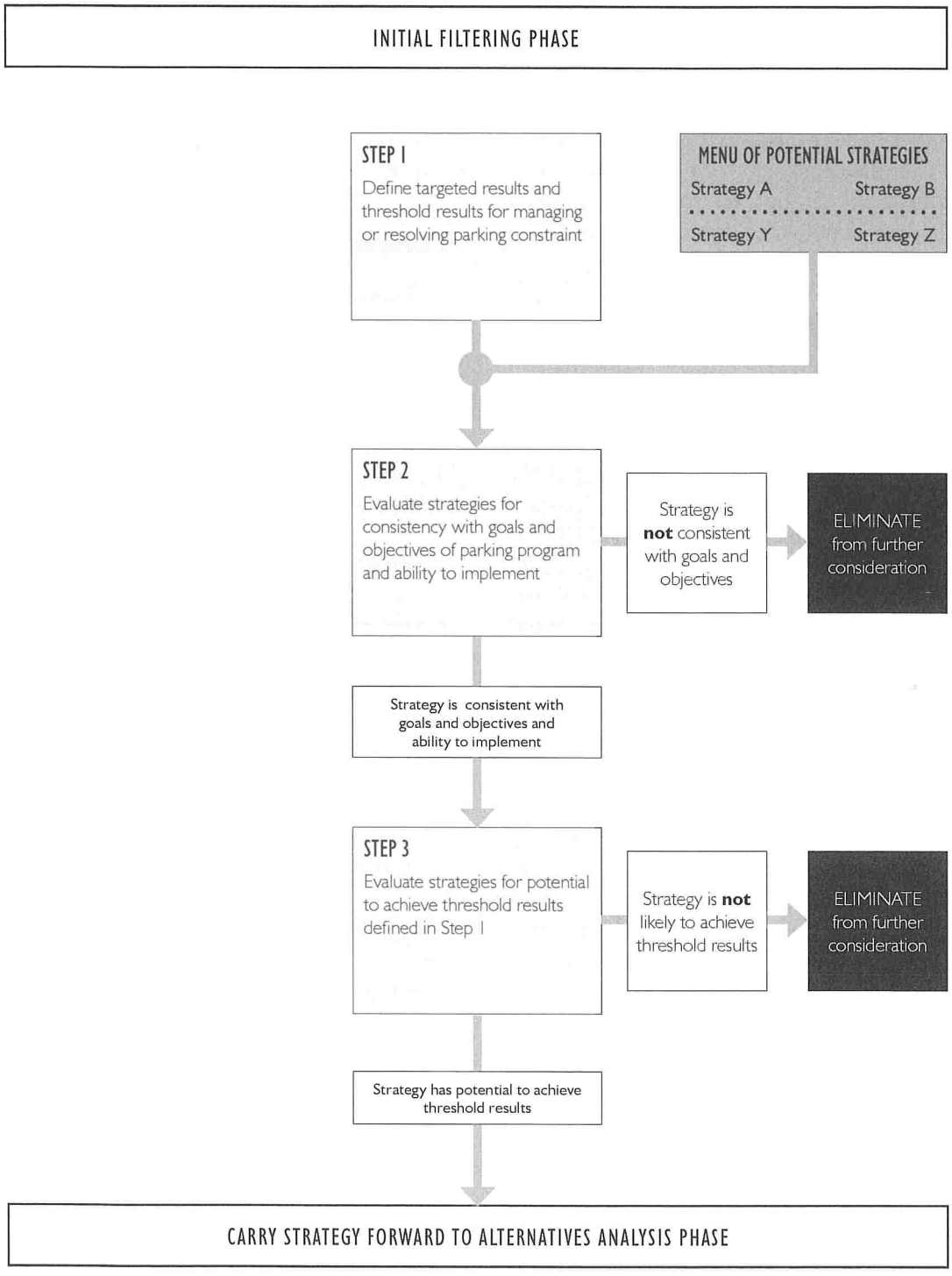
The recommended initial filtering steps are illustrated in Figure 3 and include the following:

- **Step 1**—Define the targeted results that an airport operator desires to resolve or manage a constrained parking situation. In many cases, implementation of an individual strategy may not allow an airport operator to achieve its targeted results. Therefore, the airport operator should consider what proportion of the targeted results may be acceptable to retain a strategy for further consideration as a stand-alone strategy or in combination with other strategies. This lower threshold, which represents a portion of the targeted result, is referred to as the "threshold result." The threshold result represents the minimum level of acceptability for a strategy to remain as a viable potential solution for further consideration and evaluation.
- **Step 2**—Evaluate strategies for consistency with goals and objectives of the parking program and the ability to implement the strategies within the airport environment (e.g., consider external influences such as local or state ordinances). Eliminate those strategies that are inconsistent with the airport operator's goals and objectives or that are not viable for other reasons.
- **Step 3**—Evaluate strategies for the potential to achieve the threshold results and eliminate those that do not.

Strategies that have not been eliminated in Step 3 are carried forward to the alternatives analysis phase.

Alternatives Analysis Phase

In the alternatives analysis phase, each strategy that passed the initial filtering phase is analyzed to estimate whether its



Source: Ricondo & Associates, Inc., and DMR Consulting, November 2009.

Figure 3. Strategy selection—initial filtering phase.

implementation would achieve the threshold results. Also considered in the analysis is whether the related effects of strategy implementation are consistent with the goals and objectives for the parking program. Related effects in addition to parking demand, as discussed in Chapter 5, include potential effects on financial performance, vehicle traffic, the environment (i.e., air quality), and customer service.

The following steps, depicted in Figure 4, are recommended to evaluate strategies under consideration in the alternatives analysis phase. Combinations of strategies, referred to as "packages of strategies," can be analyzed using the same steps once the analyses of individual strategies are complete. Steps in the alternatives analysis phase are as follow:

- **Step 4**—Project parking-related outcomes of each strategy or packages of strategies using predictive tools or methodologies. (See Chapter 6 for information on predicting the outcomes of selected strategies.)
- **Step 5**—Evaluate the projected parking-related outcomes of each strategy (or packages of strategies) for the ability to achieve the targeted or threshold results, and eliminate those strategies that would not achieve the threshold results.
- **Step 6**—Calculate related effects of strategies (or packages of strategies) using outputs of predictive methodologies or other information. Actual calculations in this step will depend on the objectives defined for the parking program and their prioritization. For example, projected revenues, estimated costs, vehicle traffic impacts, or environmental impacts might be of concern to the airport operator.
- **Step 7**—Evaluate the related effects of each strategy (or package of strategies) to identify effects that are unacceptable based on the goals and objectives for the parking program and eliminate these strategies. If the strategy (or package of strategies) achieves the targeted results (defined in Step 5), and if the related effects of the strategy (or package of strategies) are consistent with the goals and objectives, carry the strategy (or package of strategies) forward to the comparative analysis phase. If the effects of the strategy are consistent with the goals and objectives and the strategy achieves the threshold results but not the targeted results, carry the strategy forward to Step 8.
- **Step 8**—For strategies projected to achieve the threshold results, determine if they can be packaged with other strategies to potentially achieve the targeted results. If so, repeat analysis and evaluation Steps 4 through 7 for the package of strategies. If not, consider whether achievement of the threshold results is sufficient for further consideration and carry the strategy forward to the comparative analysis phase or eliminate the strategy.

In Steps 4 through 8, an airport operator identifies the strategies and packages of strategies that achieve the targeted results and are consistent with the airport operator's goals and objectives for the parking program. These strategies and packages of strategies represent the range of viable alternatives to manage or resolve parking constraints at an airport. The viable alternatives are carried forward to the comparative analysis phase.

If only one strategy or package of strategies is identified as viable through the alternatives analysis, the airport operator does not need to conduct a comparative analysis. This viable strategy is the preferred strategy.

Comparative Analysis Phase

If a preferred strategy or package of strategies was not identified in the alternatives analysis phase, the remaining viable alternatives are analyzed for comparison in this phase, as shown in Figure 5, to identify the best solution for the airport operator given the environment in which the airport operates, as well as the goals and objectives for the parking program. The following steps will assist an airport operator in comparing viable alternatives and identifying a preferred alternative:

- **Step 9**—Rank each alternative based on how well it meets the primary objective(s) of the parking program.
- **Step 10**—Develop a subordinate ranking based on how well each alternative meets the secondary objectives of the parking program.
- **Step 11**—Compare implementation requirements (such as financial resources, level of effort, timeframe) and related effects (such as financial performance) among alternatives. Consider other factors unique to the airport that are relevant to selection of an alternative, including the benefits derived and negative effects of each alternative.

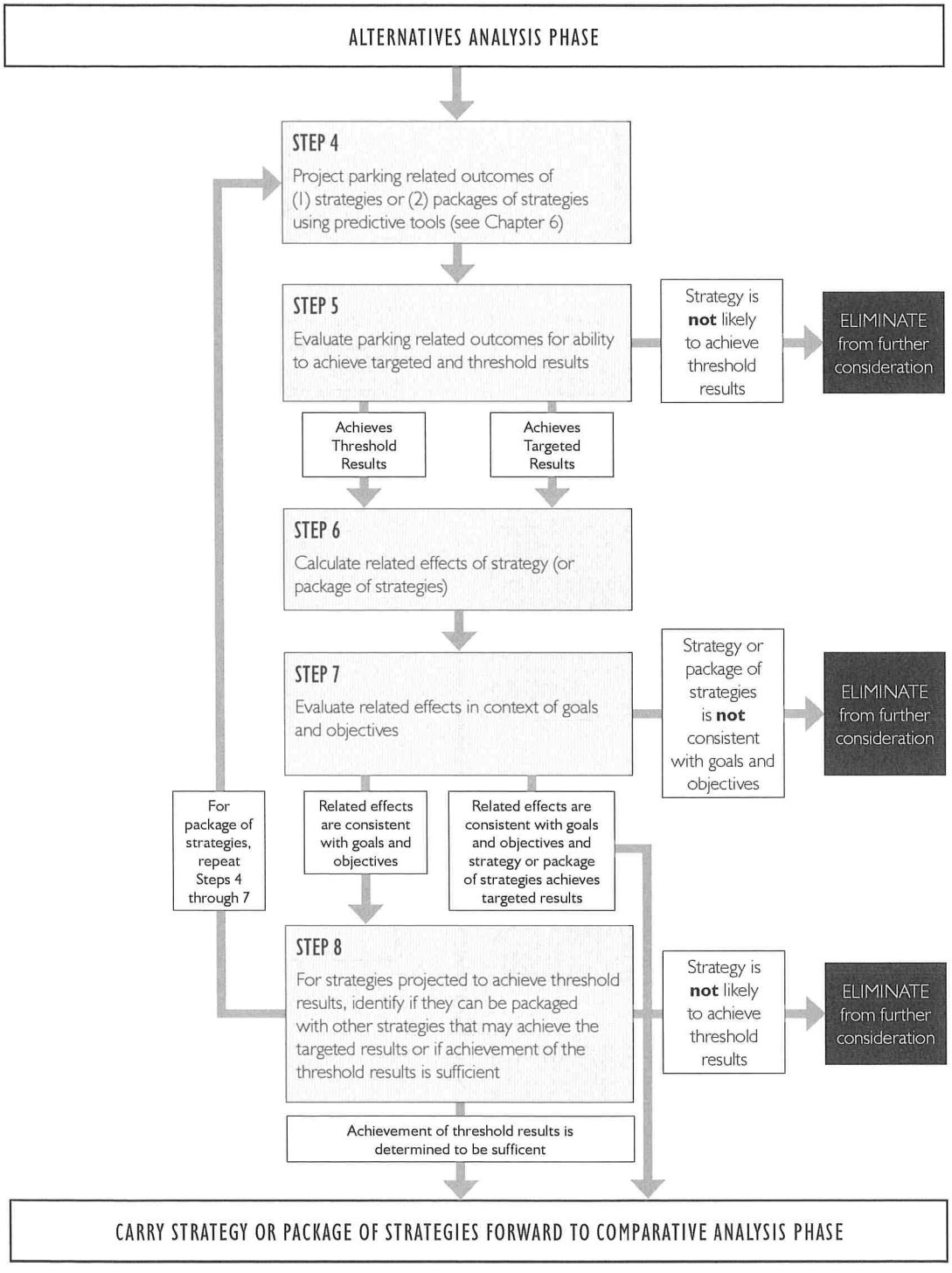
Steps 9 through 11 should provide sufficient differentiation among the viable alternatives for an airport operator to make a final selection of a preferred strategy or package of strategies to manage or resolve parking constraints.

Strategy Selection Example

An example of the strategy selection process based on a theoretical airport parking scenario follows. The subject airport is a medium-hub airport experiencing a constrained parking situation in 2009. Table 16 summarizes the key attributes of the airport's parking program and constrained parking situation for the theoretical scenario.

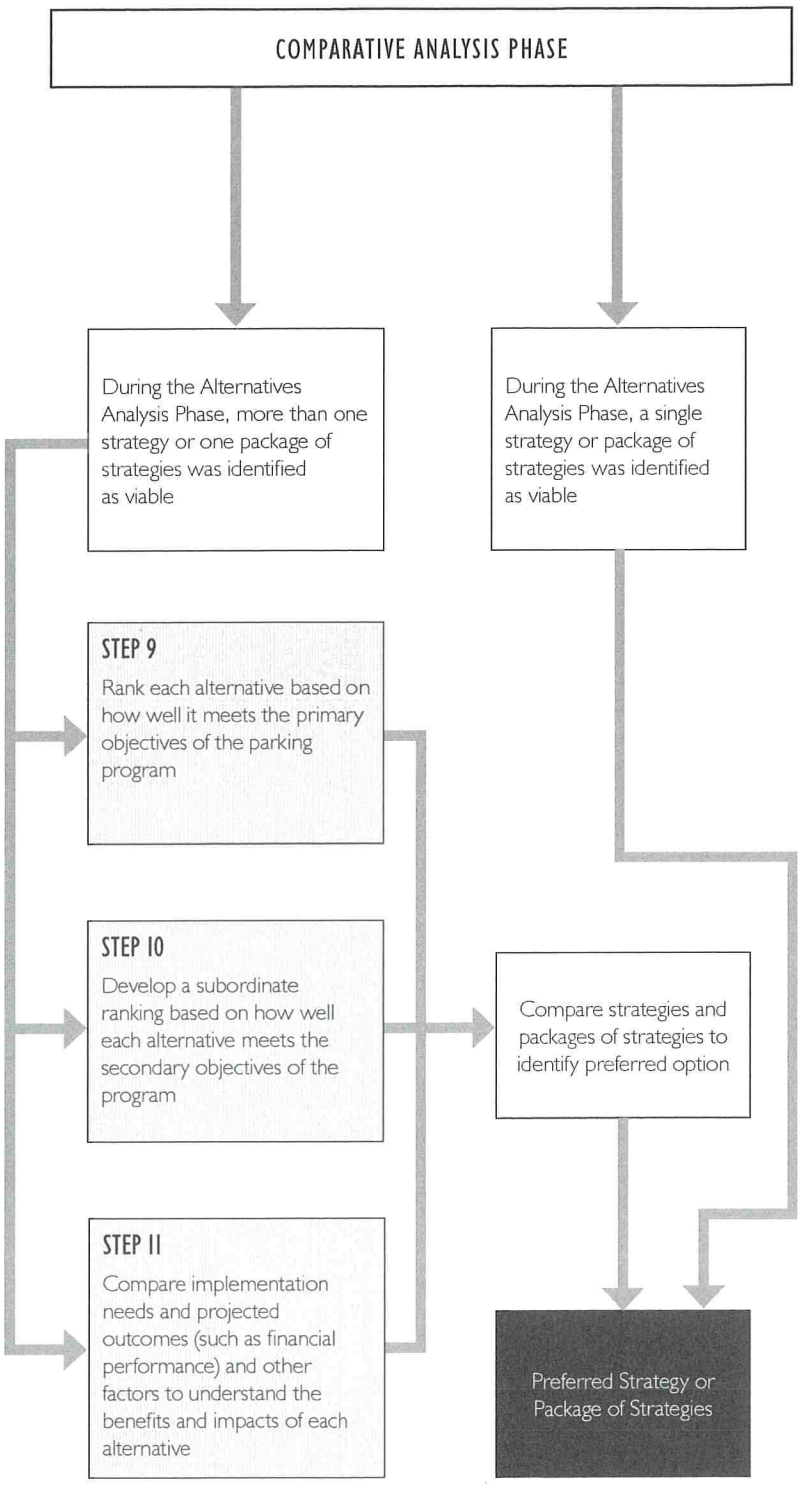
Nature and Causes of Constraints

When the garage, located in the terminal area, reaches 90% capacity, extra personnel are assigned to assist customers in



Source: Ricondo & Associates, Inc., and DMR Consulting, November 2009.

Figure 4. Strategy selection—alternatives analysis phase.



Source: Ricondo & Associates, Inc., and DMR Consulting, November 2009.

Figure 5. Strategy selection—comparative analysis phase.

Table 16. Key attributes of airport parking program and parking constraints, 2009, theoretical airport.

Attribute	Description
Objectives of Parking Program	Primary: Maintain or enhance net revenue.
	Secondary: Consider customer service implications and minimize excess vehicle traffic caused by constraints.
Additional Information Relevant to Provision and Management of Parking Program	No land is available to expand terminal area parking.
	Fifty percent of employees using terminal area parking work for employers who have the right to terminal area employee parking through lease agreements with the airport operator.
	Parking revenue control system is 2 years old. It is capable of processing differential rates, but not variable rates. Airport management will not approve the investment for system upgrades.
Airport-Operated Parking Supply	Public parking supply = Y
	Terminal area garage parking is 40% of airport-operated parking supply (0.4Y)
	Daily rate = X
	Hourly rate = 0.2X
	Remote surface parking with shuttle bus is 60% of airport-operated parking supply (0.6Y)
	Daily rate = 0.75X
Privately Operated Parking Supply	Multiple facilities with shuttle service
	Supply is 30% of airport-operated public parking supply (0.3Y)
	Daily rates vary by facility from 0.6X to 0.85X.
Employee Parking Supply	Remote employee lot serves some employees that work in the terminal area with a shuttle bus.
Customers of Public Parking Supply	Terminal area parking: short-term parkers, long-term parkers, and some employees in terminal area
	Remote parking: long-term parkers
Constrained Parking Problem	Since 2006, terminal area public parking has been full on Tuesdays through Thursdays most weeks in the spring and fall.
	Remote parking has excess capacity except for holiday periods.
	Remote employee lot has excess capacity.

Source: DMR Consulting, November 2009.

finding a space. Private automobiles are "stuffed and stacked" before the garage is closed. This adds another 5% capacity to the garage, but sometimes private automobiles remain in unofficial spaces for several days. Extra personnel were deployed in the garage for 48 days in the previous year (2008). Garage parking was closed on 20 days, and drivers of private automobiles were diverted to remote parking, or they chose to use privately operated off-airport parking. The number of private automobiles denied access to the garage is difficult to quantify because a computerized "Lot Full" sign board is activated when designated spaces are 100% full. The airport's website provides information on whether the two parking facilities have space available or are full. Vehicle traffic counts conducted at various locations within the terminal area indicate that terminal area vehicle traffic also increased during the constrained periods. The increase in vehicle traffic may indicate that (1) long-term parkers shifted to single-party drop-off modes in anticipation of busy periods, (2) short-term parkers used the terminal curbside rather than parking, or (3) long-term parkers dropped off members of their travel party at the terminal curbside before parking. During these periods, the airport operator received customer complaints, primarily from business travelers with trip durations of 2 days or less who had difficulty finding an available parking space within the garage.

Data from the revenue control system indicates the average distribution of exits by length of stay in the public parking facilities during constrained periods in spring 2009, as shown in Table 17.

Data from the O&D airline passenger survey conducted in spring 2008 indicated that the majority of customers using remote parking are traveling for nonbusiness purposes.

Table 17. Average distribution of parking exits, Tuesday through Thursday, spring 2009, theoretical airport.

Length of Stay	Proportion of Exits	
	Garage	Remote Lot
0–2 Hours	20%	0%
2–6 Hours	10%	1%
6–24 Hours	30% [a]	6%
1–2 Days	24%	10%
2–3 Days	4%	38%
3–5 Days	5%	21%
More Than 5 Days	7%	24%
Total	100%	100%

Note:

[a] Of the parking customers in the garage who park for a duration of 6–24 h, two-thirds are airline passengers and one-third are employees.

Source: DMR Consulting, November 2009.

Although the majority of long-term parkers using the garage are business travelers, the proportion of nonbusiness airline passengers increases substantially for stays of more than 3 days. This information is presented in Table 18.

Potential Strategies

The following strategies were identified for consideration in resolving the constrained parking problem at the theoretical airport.

- **Strategy A1: Adjust Rates, Traditional**—Increase the maximum daily rate in the garage to make the daily rate in the remote lot more attractive to price-sensitive customers using terminal area parking. This strategy is likely to influence a high proportion of airline passengers parking for longer than 3 days because the proportion of nonbusiness airline passengers increases with stays longer than 3 days.
- **Strategy A2: Adjust Rates, Differential**—Increase the daily rate in the garage for stays of more than 3 days to make the rate in the remote lot more attractive to price-sensitive customers staying longer than 3 days.
- **Strategy A3: Adjust Rates, Variable**—Adjust rates during the spring and fall to provide guaranteed spaces in both the garage and remote parking facilities for customers who book in advance at rates that are geared toward preserving space in the garage for customers who do not book in advance. Customers who do not book in advance are more likely to be business travelers who are willing to pay more to maintain flexibility.
- **Strategy B: Relocate Employee Parking**—Half of the employees parking in the garage can not be relocated because of lease agreements between their employers and the airport operator. The remaining employees would be required to move to the remote lot, which would free-up garage space accordingly.
- **Strategy C: Introduce a Premium Product**—Develop a premium parking product in the garage tailored to business travelers. Allocate a certain number of parking spaces for customers who most want to park in the garage and are willing to pay a premium for the privilege. The program includes two options: either purchase of a permit or access card that can be transferred among employees for a monthly fee equivalent to the fee for parking 25 days per month in the garage, or a pay-as-you-go option provided at a daily rate equivalent to 30% more than the garage rate and with no monthly payment required.
- **Strategy D: Introduce Valet Parking**—Offer curbside valet service at a premium over the daily rate for garage parking for customers that place the highest value on quick access to the terminal. Automobiles can be stored in the remote lot or elsewhere on airport property. The premium should be set to help resolve the parking constraint, while considering the effects of too many customers shifting to valet parking.
- **Strategy E: Expand the Terminal Area Parking Supply**—Add spaces to the parking supply to accommodate forecast demand over the next 10 years.

Table 18. Trip purpose by length of stay for long-term parkers, theoretical airport.

Length of Stay	Garage			Remote Lot		
	Business	Nonbusiness	Total	Business	Nonbusiness	Total
Up to 1 Day	84%	16%	100%	8%	92%	100%
1–2 Days	86%	14%	100%	12%	88%	100%
2–3 Days	78%	22%	100%	9%	91%	100%
3–5 Days	62%	38%	100%	18%	82%	100%
More than 5 Days	52%	48%	100%	23%	77%	100%

Source: DMR Consulting, November 2009.

- **Strategy F: Introduce Technology Improvements, Automated Parking Guidance System (APGS)**—Install APGS technology to guide customers to available spaces in the parking garage. In conjunction with the APGS, computerized signs will be placed along the airport entrance roadways that indicate the number of spaces available in the parking facilities.

Initial Filtering Phase

Potential strategies identified in the previous section are qualitatively evaluated in the initial filtering phase.

Step 1—Define Targeted and Threshold Results

Targeted results for the airport are defined as (1) the elimination of garage closures and (2) reduction in the number of days extra personnel are needed to manage the parking operation to 10 days or less per year. This equates to an 80% reduction in the number of days extra personnel are needed compared to 2008 numbers, and a 100% reduction in garage closures.

The airport operator defined threshold results for strategies based on whether a capital investment is needed to implement the strategy. For strategies that require a capital investment, the minimum threshold for the number of days extra personnel are needed is less than or equal to 10 days, and a threshold has not been specified for garage closures, but closures cannot exceed 2008 levels. For other strategies, the threshold of 40% of targeted results must be achieved, which is equivalent to no more than 33 days of extra personnel per year and no more than 12 garage closures per year.

Step 2—Evaluate Strategies for Consistency with Goals and Objectives

As shown in Table 19, two strategies were eliminated because they were not consistent with airport operator goals and objectives. The adjustment of rates through the use of a variable pricing strategy (A3) was eliminated because airport management was unwilling to invest in upgrades to the new parking revenue control system. The strategy to expand the terminal area parking supply (E) was eliminated because land is not available in the terminal area to accommodate an expanded garage.

Step 3—Evaluate Strategies for Potential to Achieve Threshold Results

As shown in Table 20, one strategy (C—the introduction of a premium parking product) was eliminated because it does not have the potential to achieve the threshold results. The initial determination was that the strategy would preserve spaces for customers who value parking in the garage the most, but it would not reduce garage closures or the need for extra personnel.

Initial Filtering Phase Summary

As follows, the remaining strategies will be carried through to the alternatives analysis phase to predict parking-related outcomes and assess their suitability to achieve the targeted results:

- Strategy A1: Adjust Rates, Traditional;
- Strategy A2: Adjust Rates, Differential;
- Strategy B: Relocate Employee Parking;
- Strategy D: Introduce Valet Parking; and
- Strategy F: Introduce Technology Improvements, APGS.

Alternatives Analysis Phase

Each strategy that was not eliminated in the initial filtering phase is carried through for analysis to determine its potential to achieve the threshold and targeted results and to determine

Table 19. Example strategy selection, Step 2 evaluation results, theoretical airport.

Strategy	Barriers to Adoption Based on Parking Goals and Objectives or Other Reasons?	Advance to Step 3?
A1. Adjust Rates, Traditional	No	Yes
A2. Adjust Rates, Differential	No	Yes
A3. Adjust Rates, Variable	Yes	No
B. Relocate Employee Parking	No	Yes
C. Introduce a Premium Product	No	Yes
D. Introduce Valet Parking	No	Yes
E. Expand Terminal Area Supply	Yes	No
F. Introduce Technology Improvements, APGS	No	Yes

Source: DMR Consulting, November 2009.

Table 20. Example strategy selection, Step 3 evaluation results, theoretical airport.

Strategy	Potential to Achieve Threshold Results?	Advance to Step 4?
A1. Adjust Rates, Traditional	Yes	Yes
A2. Adjust Rates, Differential	Yes	Yes
B. Relocate Employee Parking	Yes	Yes
C. Introduce a Premium Product	No	No
D. Introduce Valet Parking	Yes	Yes
F. Introduce Technology Improvements, APGS	Yes	Yes

Source: DMR Consulting, November 2009.

the compatibility of other related effects with the airport operator's goals and objectives for the parking program.

Step 4—Project Outcomes of Strategies

Using predictive methodologies, the following changes in parking-related activity were estimated for each of the remaining strategies.

- **Strategy A1: Adjust Rates, Traditional**—It is estimated that a 25% increase in the daily parking rate in the garage would eliminate garage closures, but extra personnel would be needed for approximately 20 days per year. That is, there would be a 58% reduction in extra staff needed during the year. This strategy would achieve 100% of the targeted results for garage closures and 74% of the targeted results for the number of days extra personnel would be needed; thus, this strategy would achieve the threshold results.
- **Strategy A2: Adjust Rates, Differential**—Application of this strategy would not change the daily rate for customers parking in the garage for up to 3 days. The daily rate for customers parked longer than 3 days would increase equivalent to a 25% increase in the average daily rate for each day parked. It is estimated that this strategy would reduce garage closures to 6 days per year, and extra personnel would be needed for approximately 28 days per year. That is, there would be a 42% reduction in extra staff needed during the year. This strategy would achieve 70% of the targeted results for garage closures (i.e., 14-day reduction in closures divided by the target reduction of 20 days) and 53% of the targeted results for reducing the number of days extra staff would be needed to manage the garage during constrained events (i.e., 20-day reduction divided by the target reduction of 38 days); thus, this strategy would achieve the threshold results.
- **Strategy B: Relocate Employee Parking**—Through application of this strategy, 50% of employees with garage permits would be required to park in the remote employee parking lot. The remaining 50% would remain in the garage because of contractual agreements with airport employers. Implementation of this strategy would have approximately the same result as a 25% increase in the daily rate for garage parking. This strategy would achieve 100% of the targeted results for garage closures and 74% of the targeted results for the number of days extra personnel would be needed; thus, this strategy would achieve the threshold results.
- **Strategy D: Introduce Valet Parking**—Analysis indicates that curbside valet services offered at a daily rate that is 15% higher than the daily rate for parking in the garage would eliminate garage closures and reduce the number of days extra staff would be needed to approximately 6 days per year. This strategy would achieve 100% of the targeted result for both garage closures and numbers of days extra staff are needed and, therefore, would achieve the threshold results.
- **Strategy F: Introduce Technology Improvements, APGS**—Through introduction of an APGS, the airport operator would be able to eliminate all days that extra personnel would be needed, but garage closures would increase from 20 to 38 days per year, as the extra 5% of capacity achieved in terms of spaces not typically available to the public would not be possible without management by extra personnel. Although 100% of the targeted result for extra staff would be achieved, this strategy would fail for the number of garage closures per year. Therefore, it would not achieve the targeted or threshold results established for strategies involving capital projects.

Step 5—Evaluate Strategies for Ability to Achieve Targeted or Threshold Results

Based on the analysis conducted in Step 4, Table 21 presents the recommendations on which to advance to Step 6, which were determined by evaluating whether the strategies would achieve the targeted or threshold results. Strategy F (Introduce Technology Improvements, APGS) is eliminated

Table 21. Example strategy selection, Step 5 evaluation results, theoretical airport.

Strategy	Potential to Achieve Threshold Results?	Potential to Achieve Targeted Results?	Advance to Step 6?
A1. Adjust Rates, Traditional	Yes	No	Yes
A2. Adjust Rates, Differential	Yes	No	Yes
B. Relocate Employee Parking	Yes	No	Yes
D. Introduce Valet Parking	Yes	Yes	Yes
F. Introduce Technology Improvements, APGS	No	No	No

Source: DMR Consulting, November 2009.

from further consideration as a strategy to resolve parking constraints at this time because it would not achieve the threshold results as discussed previously under Step 4.

Step 6—Calculate Related Effects of Strategies

Related effects of the strategies—such as financial, vehicle traffic, and customer service effects—were estimated based on the primary goal of maintaining or enhancing net revenue, and secondary goals of considering customer service implications and minimizing vehicle traffic impacts, with the following results:

- **Strategy A1: Adjust Rates, Traditional**—The financial, vehicle traffic, and customer service effects resulting from this strategy were estimated, with the following results:

  1. Net revenue impacts would be positive, as it is estimated that a 25% increase in the daily parking rate would result in a 7.5% increase in gross revenues, and operating costs would decrease because of a reduction in extra personnel costs for from 48 days to 20 days.
  2. The analysis of vehicle trips generated indicated that public parking exits would decrease by 1%. Public parking customers are projected to shift from parking at the airport primarily to being picked up and dropped off by private automobile or to using taxicabs and single-party limousines. A few customers are projected to shift to privately operated off-airport parking facilities and HOV modes. Shifts to single-party drop-off modes would result in additional vehicle traffic generated on the airport roadway system compared to airline passengers traveling by private automobile and parking for the duration of their trips. In addition, some customers who shift from garage parking to remote parking would pick up and drop off other members of their travel party at the terminal curbside prior to entering or after exiting the remote parking facility, which would generate additional vehicle trips. The airport operator does not have data on the number of vehicle trips generated during constrained events as the result of vehicles traveling from the closed parking facility to the terminal curbside, remote parking, and privately operated parking, but the average net daily vehicle trips on the airport roadway system would increase 1.2%. This increase would not result in an unacceptable level of service on the airport roadway system.
  3. From a customer service perspective, a 25% increase in rates is a steep increase, but rates at the airport have not been adjusted for 3 years. The airport operator believes that this rate increase is the highest increase customers would tolerate. The analysis indicates that total public parking exits would decrease 1%. These customers would shift to other modes because they are dissatisfied with the parking rate increase.

- **Strategy A2: Adjust Rates, Differential**—The financial, vehicle traffic, and customer service effects resulting from this strategy were estimated with the following results:

  1. Net revenue effects are estimated to be positive. A 25% increase in the average daily parking rate for customers parking for more than 3 days would result in a 2.5% increase in gross revenues, and operating costs would decrease as the result of a reduction in extra personnel costs from 48 days to 28 days.
  2. The analysis of vehicle trips generated indicated that public parking exits would decrease by 0.5%. Public parking customers would shift primarily to being picked up and dropped off by private automobile or to using taxicabs and single-party limousines. A few customers would shift to privately operated parking facilities and HOV modes. Shifts to single-party drop-off modes would result in additional vehicle traffic generated on the airport roadway system compared to airline passengers traveling by private automobile and parking for the duration of their trips. In addition, some customers shifting from the garage parking to remote parking would pick up and drop off other members of their travel party at the terminal curbside prior to

entering or after exiting the remote parking facility, which would generate additional vehicle trips. The airport operator does not have data on the number of vehicle trips generated during constrained events as the result of vehicles traveling from the closed parking facility to the terminal curbside, remote parking, or privately operated off-airport parking, but estimates that the average net daily vehicle trips on the airport roadway system would increase 0.8%. This increase would not result in an unacceptable level of service on the airport roadway system.
3. From a customer service perspective, a 25% increase in parking rates is a steep increase, but rates have not been adjusted for 3 years. The airport operator believes that this rate increase is the highest increase customers would tolerate. A differential rate has not been introduced at the airport, and customers may have difficulty understanding the rate or may feel it is unfair for customers who park for a longer term to be singled out for a rate increase. The analysis indicates that total public parking exits would decrease by 0.5%. These customers would shift to other modes because they are dissatisfied with the parking rate increase.

- **Strategy B: Relocate Employee Parking**—The financial, vehicle traffic, and customer service effects resulting from this strategy were estimated with the following results:

1. Net revenue effects are estimated to be positive. Each parking space occupied by an airline passenger that was previously occupied by an airport employee will have a positive effect on net revenues, as the fee for employees to park in the garage is a small fraction of the daily rate for public parking in the garage. Although the airport operator does not have data to estimate the increase in gross revenues from implementation of this strategy, the airport operator assumed that implementation of this strategy would result in an approximate 1% increase in gross revenues. The strategy would also decrease operating costs because of a reduction in extra personnel costs from 48 days to 28 days.
2. In this theoretical example, the airport operator does not have data on the number of vehicle trips generated during constrained events as the result of vehicles traveling from the closed parking facility to the terminal curbside, remote parking, or privately operated parking facilities, but estimates that the average net daily vehicle trips on the airport roadway system would decrease 0.2%.
3. From a customer service perspective, implementation of this strategy would be an improvement for airline passengers using the parking garage, and would have negative customer service implications for airport employees working in the terminal area who would lose their ability to park in the garage. Employees and their employers may be dissatisfied.

- **Strategy D: Introduce Valet Parking**—The financial, vehicle traffic, and customer service effects resulting from this strategy were estimated with the following results:

1. Gross revenues would increase about 2% and operating costs would decrease as a result of a reduction in extra personnel costs from 48 days to 6 days. Factoring these changes in with the estimated costs to operate the valet service, implementation of this strategy would have a negative effect on the net revenues generated by public parking.
2. Vehicle trips generated by customers using valet parking would increase because of the shuttling activity required for the parking staff to transport the vehicle from the terminal curbside to the valet parking area and to transport the valet parking employee back to the terminal area (and vice versa on the airline passenger's return trip). The airport operator does not have data on the number of vehicle trips generated during constrained events as a result of vehicles traveling from the closed parking facility to the terminal curbside, remote parking, and privately operated parking facilities, but estimates that the average daily net vehicle trips on the airport roadway system would increase 0.5%. This increase would not result in an unacceptable level of service on the airport roadway system.
3. Implementation of this strategy would be a customer service improvement for airline passengers who prefer terminal area parking.

Step 7—Evaluate Related Effects in Context of Goals and Objectives

Based on the analysis in Step 6, Table 22 presents the recommendations on which strategies to advance to Step 8, which was determined by evaluating whether the strategies were compatible with the airport operator's goals and objectives for the parking program. All strategies were carried forward to Step 8, except for Strategy D (Introduce Valet Parking), because it did not meet the financial objectives of preserving or enhancing net revenues.

Step 8—Identify Packages of Strategies

The strategies that would achieve the threshold results but not the targeted results—Strategies A1, A2, and B—were

Table 22. Example strategy selection, Step 7 evaluation results, theoretical airport.

Strategy	Potential to Achieve Threshold Results?	Potential to Achieve Targeted Results?	Compatibility of Related Effects to Goals and Objectives for Parking Program?	Advance to Step 8?
A1. Adjust Rates, Traditional Rates	Yes	No	Yes	Yes
A2. Adjust Rates, Differential Rates	Yes	No	Yes	Yes
B. Relocate Employee Parking	Yes	No	Yes	Yes
D. Introduce Valet Parking	Yes	Yes	No	No

Source: DMR Consulting, November 2009.

reviewed to determine if the strategies could be packaged to improve results. Two strategy packages were identified:

- **Strategy Package 1**—Adjust Rates, Traditional (Strategy A1) plus Relocate Employee Parking (Strategy B); and
- **Strategy Package 2**—Adjust Rates, Differential (Strategy A2) plus Relocate Employee Parking (Strategy B).

In addition to the two strategy packages, the airport operator decided to retain Strategies A1 and B as stand-alone strategies because both would almost achieve the targeted results. Table 23 summarizes the strategies and packages of strategies retained at this step.

The Step 4 through 7 analyses of the two strategy packages defined in Step 8 are discussed below.

Return to Step 4 for Strategy Packages—Project Outcomes of Strategies

- **Strategy Package 1** (Strategy A1: Adjust Rates, Traditional plus Strategy B: Relocate Employee Parking)—By combining a traditional rate increase with elimination of half of the employee parking permits for the parking garage, this strategy package is estimated to eliminate garage closures and the need for extra personnel to manage the garage because implementation of the strategy package would resolve the constraint. Therefore, this strategy package would achieve the targeted results.
- **Strategy Package 2** (Strategy A2: Adjust Rates, Differential plus Strategy B: Relocate Employee Parking)—By combining a differential rate increase with elimination of half of the employee parking permits for the parking garage, this strategy package is estimated to achieve 100% of the targeted results for garage closures, and extra personnel would be needed on 10 days to manage the garage during constrained periods. Therefore, this strategy package would achieve the targeted results.

Table 23. Example strategy selection, Step 8 summary of strategies retained, theoretical airport.

Strategy	Achieves Targeted Results?	Advance to Next Step of Analysis?
A1. Adjust Rates, Traditional	No[a]	Yes—Step 9
A2. Adjust Rates, Differential	No	No
B. Relocate Employee Parking	No[a]	Yes—Step 9
Strategy Package 1 (A1 + B)	To be determined	Yes—Step 4
Strategy Package 2 (A2 + B)	To be determined	Yes—Step 4

Note:

[a] Strategy almost achieves targeted and threshold results, so airport operator decided to advance the strategy.

Source: DMR Consulting, November 2009.

Return to Step 5 for Strategy Packages—Evaluate Strategies for Ability to Achieve Results

Based on the analysis conducted in Step 4, both packages of strategies are projected to achieve the targeted results. Table 24 presents recommendation on which strategy packages to advance to Step 6 based on the results of the evaluation of the ability of the strategy packages to achieve either the targeted results or the threshold results.

Return to Step 6 for Strategy Packages—Calculate Related Effects of Strategies

Related effects of the strategy packages, such as financial, vehicle traffic, and customer service effects, were estimated based on the primary goal of preserving net revenues and secondary goals of considering customer service implications and minimizing vehicle traffic impacts.

- **Strategy Package 1** (Strategy A1: Adjust Rates, Traditional plus Strategy B: Relocate Employee Parking)—The financial, vehicle traffic, and customer service impacts were estimated with the following results:

  1. It is estimated that implementation of Strategy Package 1 would have approximately the same gross revenue effects as implementation of the 25% traditional rate increase

Table 24. Example strategy selection, Step 5 evaluation results for strategy packages, theoretical airport.

Strategy	Potential to Achieve Threshold Results?	Potential to Achieve Targeted Results?	Advance to Step 6?
Strategy Package 1 (A1 + B)	Yes	Yes	Yes
Strategy Package 2 (A2 + B)	Yes	Yes	Yes

Source: DMR Consulting, November 2009.

(i.e., a 7.5% increase in gross revenues). Operating costs would decrease with the elimination of the need for the 48 days of extra personnel costs to manage the constrained parking conditions.

2. The analysis indicated that public parking exits would decrease 1%. Public parking customers are projected to shift primarily to being picked up and dropped off by private automobile or to using taxicabs and single-party limousines. A few customers are projected to shift to privately operated parking facilities and HOV modes. Shifts to single-party drop-off modes would result in additional vehicle traffic generated on the airport roadway system compared to airline passengers traveling by private automobile and parking for the duration of their trips. In addition, some customers shifting from the garage to remote parking will pick up and drop off other members of their travel party at the terminal curbside prior to entering or after exiting the remote parking facility, which would generate additional vehicle trips. In this theoretical example, the airport operator does not have data on the number of vehicle trips generated during constrained parking events as the result of vehicles traveling from the closed parking facility to the terminal curbside, remote parking, and privately operated parking, but estimates that the average net daily vehicle trips on the airport roadway system would increase 1.2%, but the level of service on the airport roadway system would not decrease.
3. From a customer service perspective, although a 25% increase in the parking rate is a steep increase, rates have not been adjusted for 3 years. The airport operator believes that this is the highest rate increase customers would tolerate. The analysis indicated that total public parking exits would decrease 1%. These customers would shift to other modes because they are dissatisfied with the parking rate increase. Combined with the additional capacity from relocating employees, customers using the garage would be able to find a parking space without assistance from personnel and would not be diverted to remote parking, which is a customer service improvement. There would be negative customer service implications for airport employees working in the terminal area who have lost the ability to park in the garage. The employees and their employers may be dissatisfied.

- **Strategy Package 2** (Strategy A2: Adjust Rates, Differential plus Strategy B: Relocate Employee Parking)—The financial, vehicle traffic, and customer service impacts were estimated with the following results:

  1. It is estimated that implementation of Strategy Package 2 would have approximately the same gross revenue impacts as implementation of the differential rate structure for the parking garage (i.e., a 2.5% increase in gross revenues). Operating costs would decrease with the reduction from 48 days to 10 days of excess personnel needed to manage the constrained parking conditions.
  2. The analysis indicated that public parking exits would decrease by 0.5%. Public parking customers are projected to shift primarily to being picked up and dropped off by private automobile or to using taxicabs and single-party limousines. A few customers are projected to shift to privately operated parking and HOV modes. Shifts to single-party drop-off modes would result in additional vehicle traffic generated on the airport roadway system compared to airline passengers who travel by private automobiles and park for the duration of their trips. In addition, some customers shifting from the garage to remote parking would pick up and drop off other members of their travel party at the terminal curbside prior to entering or after exiting the remote parking facility, which would generate additional vehicle trips. In this theoretical example, the airport operator does not have data on the number of vehicle trips generated during constrained events as a result of vehicles traveling from the closed parking facility to the terminal curbside, remote parking, and privately operated parking, but estimates that the average net daily vehicle trips on the airport roadway system would increase 0.8%, but the level of service on the airport roadway system would not decrease.
  3. From a customer service perspective, although a 25% rate increase is a steep increase, rates have not been adjusted for 3 years. The airport operator believes that

Table 25. Example strategy selection, alternatives analysis phase summary, theoretical airport.

Strategy	Achieves Targeted Results?	Airport Operator Decision to Carry Forward?	Advance to Step 9?
A1. Adjust Rates, Traditional	No	Yes[1]	Yes
A2. Adjust Rates, Differential	No	No	No
B. Relocate Employee Parking	No	Yes[1]	Yes
Strategy Package 1 (A1 + B)	Yes	Yes	Yes
Strategy Package 2 (A2 + B)	Yes	Yes	Yes

Note:

[1] Airport operator decided to carry forward the strategy because it almost achieves the targeted results.

Source: DMR Consulting, November 2009.

this is the highest rate increase customers would tolerate. A differential rate has not been introduced at the airport, and customers may have difficulty understanding the rate or may feel it is unfair for customers parking for a longer duration to be singled out for a rate increase. The analysis indicated that total public parking exits would decrease by 0.5%. These customers would shift to other modes because they are dissatisfied with the parking rate increase. Combined with the additional capacity from relocating employees, customers using the garage would be able to find a space without assistance from personnel and would not be diverted to remote parking, which is a customer service improvement. There would be negative customer service implications for airport employees working in the terminal area who have lost the ability to park in the garage. The employees and their employers may be dissatisfied.

Return to Step 7—Evaluate Related Effects in Context of Goals and Objectives

The related effects of the two strategy packages were considered to be compatible with the airport operator's goals and objectives for the parking program.

Alternatives Analysis Phase Summary

Table 25 summarizes the results of the analysis of the strategies and strategy packages that are to be carried forward into the comparative analysis phase.

Comparative Analysis Phase and Strategy Selection

The comparative analysis phase consists of three steps (Steps 9 through 11) that may be conducted simultaneously. These steps are discussed together in this section.

In this theoretical example, the airport operator ranks each strategy and strategy package from 1 (best) to 4 (worst) based on the primary and secondary goals of the parking program, as shown in Table 26. Net revenues and excess vehicle trips can be ranked based on quantitative data, but the ranking for customer service is subjective. Strategy B, Relocate Employee Parking, was ranked as the most desirable strategy from a customer service standpoint, because management has ranked customer service for airline passengers as more important than customer service for employees. The airport operator ranked Strategy Package 2 as the worst for customer service because, even though fewer customers would be subject

Table 26. Example strategy selection, ranking of strategies based on primary and secondary goals of parking program, theoretical airport.

Strategy	Preserve or Increase Net Revenues Ranking	Excess Trips Generated Ranking	Customer Service Ranking
A1. Adjust Rates, Traditional	1	3	2
B. Relocate Employee Parking	3	1	1
Strategy Package 1 (A1 + B)	1	3	3
Strategy Package 2 (A2 + B)	2	2	4

Source: DMR Consulting, November 2009.

to a rate increase, it is believed that customers would have difficulty understanding and accepting the concept of the differential rates and that the strategy package would also inconvenience employees. Although the traditional rate adjustment (Strategy A1) and Strategy Package 1 would have the greatest effect on numbers of vehicle trips generated, airport management determined that Strategy A1 and Strategy Package 1 would not degrade the level of service on the airport roadway system.

Based on the comparative analysis, the airport operator in this scenario selects Strategy Package 1 because it is ranked the highest for the primary goal of preserving or increasing net revenues, at a rate level that the airport operator believes the market will tolerate, given that parking rates have not been raised in 3 years. Employee parking in the terminal area is exacerbating the constrained parking situation. For several years, the airport operator has recognized that each space occupied by an employee vehicle represents lost revenue in the garage. The airport operator believes that, from a public relations standpoint, it will be easier to relocate employees if the effects of resolving the problem are shared between employees and airline passengers.

If the airport operator is concerned about customer service impacts or vehicle trip generation with the 25% rate increase, it could analyze Strategy Package 1 with a lower parking rate increase to determine if the targeted results could be achieved. If customer service were the primary goal rather than net revenues, Strategy B, the relocation of employees to remote parking, would have been selected as the preferred strategy.

CHAPTER 8

Evaluating the Effectiveness of Strategies

The data needed and approaches for measuring whether the strategies implemented to resolve constrained parking conditions achieved the desired outcome on parking and ground access travel behavior are described in this chapter. Evaluating the outcomes of strategies implemented allows an airport operator to judge whether a strategy or multiple strategies were successful within the context of the goals and objectives for the parking program. Furthermore, development of an understanding of parking and ground access travel behavior can provide an airport operator insight to facilitate the future formulation of strategies, as discussed in Chapters 6 and 7.

The primary focus of this chapter is on ways to measure the effectiveness of strategies implemented to resolve constraints on an ongoing basis (strategies to respond to ongoing constraints are discussed in Chapter 5). Short-term strategies (also discussed in Chapter 5), on the other hand, are operational solutions whose success can often be judged during the constrained situation and adjusted accordingly, and data are not typically collected to analyze the effectiveness of such strategies. In some cases, however, such as the use of temporary overflow parking, an airport operator may track information on the overflow parking operation, such as the number of days it is in use and the number of automobiles parked.

The typical data sources described in this chapter are useful for understanding airline passenger parking and travel patterns, and are similarly useful for understanding the changes in parking and travel patterns that have occurred following implementation of the strategies to address constrained parking. The information in this chapter on measuring the effects of parking strategies provides guidance on how the data identified in this section can be used independently or in their entirety to quantify the results of strategies implemented to reduce parking constraints.

Data Sources

At a basic level, an airport operator may want to measure how parking behavior changed after strategies were implemented. Expanding this evaluation to consider the relationship between changes in parking behavior and the use of other ground access modes provides a more holistic view of the effects of strategy implementation. For example, shifts between ground access modes result in changes in levels of vehicle traffic on airport and regional roadways, and changes in vehicle traffic effect levels of mobile source emissions generated. Shifts between different parking products and from parking to other modes also affect parking revenues. Understanding these relationships and how a strategy implemented to influence parking behavior under constrained parking conditions may influence behavioral changes beyond the parking system itself is relevant to the evaluation of a strategy or multiple strategies. Therefore, an airport operator should consider collecting and maintaining data on the use of other ground access modes that airline passengers use to access and depart the airport.

To measure changes in parking and ground access activity, data are necessary from periods both before and after a strategy is implemented. Before-and-after data can be collected in one of the following two ways:

- Through an ongoing data collection program or
- By planning in advance of strategy implementation to collect the necessary before data, and by collecting data after the strategy has been implemented.

An ongoing data collection program provides the airport operator and others with the flexibility to evaluate the outcomes of strategies that may be implemented within a short timeframe when there otherwise may not have been sufficient time for data collection prior to strategy implementation. However, it should also be recognized that the airport's existing parking

revenue control systems, ongoing survey programs, and other data sources that are part of the airport operator's ongoing data collection program may not collect, calculate, and readily report the data that may be most effective in measuring the success of a strategy. As a result, the potential limitations of these two approaches to data collection should be considered.

Data should be evaluated, as discussed in the next section of this chapter, in consideration of other factors that could influence parking and travel patterns at an airport to understand whether any changes are a direct result of implementing a strategy or a result of other factors that may have influenced airline passenger behavior. Collection of information to understand other influences on parking and travel patterns should be considered. What information is relevant to an analysis depends on the unique environment and conditions at a specific airport. Examples of relevant information include the following:

- Changes in local or national economic conditions;
- Introduction of low-cost airline service on airline passenger activity (e.g., annual enplanements) and parking activity (e.g., transactions, revenue, space demand); and
- Changes in pricing or supply of other ground access modes, including privately operated off-airport parking and HOV modes.

Typical data sources for measuring changes in parking activity and other modes, as well as how the data are obtained, include the following:

- Parking revenue control system,
- Supplemental parking data,
- Airline O&D passenger survey data,
- Vehicle activity and vehicle occupancy counts, and
- Enplaned O&D passenger activity.

Parking Revenue Control System

The parking revenue control system is the most important data source an airport operator can use for measuring changes in parking activity following the implementation of strategies to address constrained parking. A variety of information can be collected from a parking revenue control system, depending on the sophistication of the system and the reports generated. Sometimes data that are easy to capture and retain if programmed into the parking revenue control system in advance can be costly, time-consuming, or even impossible to retrieve if requested after system programming is complete. Therefore, it is important for members of an airport operator's staff that have an interest in parking performance from a variety of perspectives to collaborate on determining which data are necessary for developing an understanding of overall changes in parking volume, changes in parking duration, changes in use between facilities, changes in revenue, and other metrics. The data should be provided in formats that lend themselves to data manipulation or meaningful review.

Data obtained from the parking revenue control system can be analyzed and postprocessed to provide a range of statistics in a variety of reporting formats. The reports can range from very detailed ticket-level information to high-level monthly and annual statements of parking transactions and revenues. However, for purposes of assessing constrained parking activity, at a minimum, the following basic data should be captured and reported.

- **Vehicle exits**—Vehicle exits or parking transactions by facility provide the airport operator and others with the ability to determine overall changes in parking activity and changes by facility. It may be important to review exit data by hour of the day, day of the week, and month of the year. Parking transaction data may be used to generate benchmarks, such as transactions per space, revenue per transaction, and parking transactions per O&D passenger.
- **Vehicle length-of-stay distribution**—A distribution of vehicle exits by length of stay by facility provides an airport operator with an understanding of potential changes in the duration of facility use following implementation of different strategies, such as parking rate changes, allocation changes, or the introduction of new products. Length-of-stay data should be collected in increments that are meaningful to the specific airport situation. Generally, it is better to collect the information in smaller increments that later can be aggregated during analysis. The length of stay may correspond to the rate structure, or another increment if the rate structure does not provide enough information to understand trip durations. One suggested distribution would be to collect information on stays of 24 h or less in hourly increments, and stays of more than 24 h in daily increments. If special pricing is in effect during the first hour, such as providing the first 30 min free of charge, the first hour should be segmented into two 30-min increments.
- **Parking revenue**—Parking revenue by facility by length of stay, month, and year provides the ability to generate benchmarks, such as revenue per space, revenue per transaction, and parking revenue per O&D passenger. Although parking revenue will be generated primarily by resident O&D passengers, this benchmark is somewhat useful in comparing performance between years for similar periods and for assessing the implication of parking rate changes. A comparison of parking revenues generated by the number of exits by length of stay is important for understanding patterns that affect revenue.

- **Facility occupancy**—A count of vehicles in a facility at a specific time or times during the day or evening can help parking staff determine if a facility will become constrained. For example, maximum daily parking occupancy and minimum daily (typically overnight) occupancy by facility are helpful metrics in assessing overall parking demands by day of the week and seasonally throughout the year. These data also are useful for comparing similar periods before and after strategy implementation. Newer parking revenue control systems are typically able to provide this information, while older ones can not.

Supplemental Parking Data

If an airport operator can not collect parking occupancy data from its parking revenue control system, it is recommended that overnight parking occupancy be collected manually by facility. Even when the parking revenue control system provides occupancy data, the collection of overnight counts, including a vehicle license plate inventory, may be useful to validate the data collected from the parking revenue control system (e.g., parking management audits). Overnight license plate inventories also serve as a backup for estimating length of stay when customers lose their parking tickets and when no automated license plate recognition systems are in use. The license plate inventory data also are useful for helping customers locate their cars when they can not remember where they parked.

Airline O&D Passenger Survey Data

Airline O&D passenger survey data are important for understanding how airline passenger ground access travel patterns may have changed in response to strategies implemented to resolve constrained airport parking. Data on private automobiles that were parked can be collected from the parking revenue control system; however, data on the use of other modes, such as private automobiles picking up and dropping off airline passengers at the curbside, typically are not captured.

Data obtained from an airline O&D passenger survey provide a wealth of information on airline passenger characteristics and travel behavior, including use of airline passenger access modes to and from the airport, travel party size, place of residence, place of trip origin, and trip purpose.

Data from the O&D survey that are relevant to understanding the demographics of the parking customer, as well as changes following implementation of strategies to resolve constrained parking, are presented in this section and followed by a discussion of data collection methodology.

- **Trip purpose**—Trip purpose is an important factor in how airline passengers make mode choices. Trip purpose data enable the analyst to determine the proportion of parkers traveling for business and for pleasure. In general, business travelers are more time-sensitive and less price-sensitive than nonbusiness travelers, and their business trips are typically subsidized by their employers. It can be expected that a smaller proportion of parkers traveling for business purposes than nonbusiness travelers will divert from terminal area parking when parking rates are increased.
- **Resident status**—Resident status is a determinant of mode choice, since residents have a more extensive knowledge of specific modes available, and only residents may park a private automobile for the duration of a trip. The importance of understanding customer behavior by resident status and trip purpose was described in Chapter 1. Since most of the long-term parking supply and a large amount of the short-term parking supply is used by resident airline passengers, it is important to estimate the number of resident O&D passengers using the airport. It is equally important to estimate the number of nonresident O&D passengers that generated private vehicle trips by greeters and well-wishers, as some of those people use short-term parking. Before-and-after data, including numbers of residents, will provide information on whether changes in parking activity may have occurred as a result of changes in the proportion of residents and nonresidents.
- **Access mode**—Access mode share provides the analyst with information on all travel modes used by airline passengers to access and depart the airport. This information, along with resident and nonresident status and trip purpose, allows the analyst to understand mode preferences by resident business, resident nonbusiness, nonresident business, and nonresident nonbusiness travelers. It is valuable to evaluate this information before and after strategies have been implemented to understand how customers may have shifted modes. Looking at overall mode share as well as mode share by market segment allows the analyst to understand if overall mode shifts have occurred as a result of shifts in the proportion of airline passengers by market segment, strategies implemented to influence behavior, or potentially for other reasons. The number of passengers using each mode can be estimated by applying the mode share for the time period of the survey to the volume of O&D passengers for a comparable time period, such as average daily O&D passengers.
- **Private automobile disposition**—Survey data should capture the proportion of passengers using private automobiles that have been picked up and dropped off by greeters and well-wishers versus those that parked their private automobiles for the duration of their trips. The pickup and drop-off customers can be further segmented into short-term parkers and those who used the curbside only. Long-term parkers can be segmented by parking facility used.

- **Airline passenger travel party size**—Travel party size data enable the analyst to estimate the number of single-party vehicle trips generated by airline passengers to and from the airport on a daily basis. For a long-term parker, the number of vehicle trips generated would be calculated by dividing the number of passengers that accessed the airport by the "private automobile parked for the duration of the trip" mode by travel party size. For an airline passenger dropped off and picked up by a single-party vehicle, the number of vehicle trips generated would be calculated by dividing the number of passengers dropped off by private vehicle by travel party size and then by multiplying the resulting number by two to account for the vehicle trips departing from and returning to the airport that are not transporting airline passengers. It can be assumed that the data from the enplaning survey can be doubled to arrive at the number of daily trips. This methodology (discussed later in this chapter in the section on measuring the effects of parking strategies) also allows the analyst to estimate the number of rental car trips, taxicab trips, and single-party limousine trips.
- **Length of stay**—Length of stay information allows the analyst to determine trip durations for different customers by customer segment, mode, private automobile disposition, and parking facility. Data from the parking revenue control system provide length-of-stay data, but do not reveal length of stay by customer segments or by airline passenger travel party size.

Surveying enplaning passengers is more efficient than surveying deplaning passengers because enplaning passengers have time in the terminal and in hold rooms prior to boarding their flights whereas deplaning O&D passengers do not. An enplaning passenger survey is typically administered beyond security. It is often assumed that an airline passenger's mode of airport egress is the same as the mode of access, which would almost always be the case for the airline passenger who parks an automobile at the airport before departing on the airline trip. This simplifying assumption significantly reduces the effort and costs associated with administering airline passenger surveys.

An airport operator may collect O&D survey data periodically, such as every 2 to 5 years, to monitor airline passenger demographics and travel behavior. Airport operators also may collect such data for a specific purpose, such as a master plan. If an O&D survey is conducted at regular intervals, it can be used to measure before-and-after behavior subsequent to implementation of a strategy, with the recognition that other changes may have occurred during the time period between surveys that also may have affected travel behavior. It is important for questions and answer choices to be similar each time the survey is administered so that the results from survey to survey are comparable. It is also important to carefully consider the timing of survey implementation, such as collecting data at a "typical" travel time, when business and nonbusiness travel is not unusually high or low.

Airline O&D Passenger Survey Conducted by an Airport Operator (Los Angeles World Airports)

Los Angeles World Airports, the operator of Los Angeles International Airport (LAX), administers an O&D survey of departing airline passengers every 4 to 5 years. The most recent survey was conducted in 2006. The sampling occurred during August and October to capture peak and "typical" travel periods. Survey responses were collected from 18,458 O&D airline passengers. (*22*)

Airline O&D Passenger Survey Conducted by an MPO (Metropolitan Washington Council of Governments)

The Metropolitan Washington Council of Governments, the MPO for the greater Washington, D.C. area, conducted an O&D survey of departing airline passengers at Ronald Reagan Washington National Airport (DCA), Washington Dulles International Airport (IAD), and Baltimore/Washington International Thurgood Marshall Airport (BWI) during a 2-week period in October 2007. Approximately 19,100 usable responses were obtained, with 24%, 39%, and 37% of responses, respectively, from airline passengers at DCA, IAD, and BWI. The survey was jointly funded by the Metropolitan Washington Airports Authority and the Maryland Aviation Administration. It is the eighth survey that has been conducted since 1981. (*8*)

For more information on conducting an O&D survey, please refer to *ACRP Report 26: Guidebook for Airport-User Survey Methodologies,* which is the guidebook developed in support of ACRP Project 03-04. (*21*)

Vehicle Activity and Vehicle Occupancy Counts

For airports with congested roadway and curbside systems, the airport operator may want to understand if parking strategies have caused a mode shift that resulted in a diversion of vehicle traffic from the curbside (i.e., passenger pickup and drop-off) to the parking facilities or vice versa. Although some airport operations personnel may have an intuitive feel for this information, supporting data are derived either through an O&D passenger survey, as described in the previous section, or estimated from a variety of data sources. The latter approach will require the distillation of data from different sources and time periods, and supplemental data from manual or automated traffic counts. Vehicle count data by mode and data on the number of occupants by mode are necessary for estimating airline passenger mode share.

Although some airports use automatic vehicle identification (AVI) systems to collect detailed activity data associated with commercial vehicle traffic using the airport curbsides, these systems track only those vehicles that are mounted with a radio-frequency-based transponder. However, these AVI data, in combination with roadway traffic counts of all vehicles accessing the airport, have been used to obtain estimates of private automobiles and other vehicles that are not tracked by the AVI system.

Vehicle Traffic Generated by Mode

Automatic traffic recorders (ATRs) can be temporarily installed on the airport roadway system, including the terminal curbsides, parking access roadways, recirculation roadways, and in the vicinity of cell phone lots to collect vehicle counts for time periods before and after implementation of a strategy. Permanent count stations using imbedded loop detectors or other technology also have been installed by some airport operators interested in obtaining an ongoing database of traffic activity. These traffic counting systems can be configured to estimate vehicle classification based on the number of axles per vehicle, but are limited in their ability to identify specific modes. Other means can be used to collect mode-specific distribution to supplement the vehicle counts as follows:

- An AVI system tracks trips by commercial vehicles that have been mounted with a radio-frequency-based transponder (e.g., toll tag) and can provide the commercial vehicle distribution by mode for all vehicles affixed with transponders. Commercial vehicle trips can be subtracted from the total traffic counts obtained using ATRs or permanent imbedded loops to provide the share of traffic by private automobiles and other vehicles not tracked by the AVI system, which includes maintenance vehicles, rental cars, and "nontenant" commercial vehicles. Traffic counters and AVI readers should be located in the same areas to ensure that the data are comparable.
- Numbers and types of commercial vehicles can be estimated through other tracking mechanisms, such as taxicab and limousine dispatch counts and HOV schedules, if an AVI system is not available.
- Manual vehicle classifications by mode can be obtained. Personnel with handheld computer devices or clipboards would be stationed at different points on the roadway and terminal curbsides to count vehicles by a variety of classifications.

These methods to capture mode distribution do not allow for the classification of rental cars and private automobiles. Activity at a terminal curbside that appears to be generated by private automobile will typically include (1) rental car customers dropping off members of their travel party at the curbside prior to returning the rental car, (2) long-term parkers and short-term parkers dropping off members of their travel party prior to parking the automobile, (3) recirculating vehicles that make multiple passes of the curbside in advance of meeting passengers for pickup, and (4) bypassing vehicles accessing an adjacent terminal that drive past the terminal while traveling to or from the adjacent terminal. An O&D survey is more effective at estimating the share of parking customers versus those that are picking up and dropping off passengers, and estimating the share of rental cars versus private automobiles.

Finally, nonpassenger vehicles at the terminal curbsides, such as enforcement personnel, employees, airport maintenance, and delivery vehicles, will be captured in the non-AVI automatic traffic counts and will need to be separated from the vehicle traffic related to airline passengers. Only some of this vehicle traffic can be identified through a manual classification count.

Vehicle Occupancy Counts

Vehicle counts may provide a distribution of vehicles by vehicle type or mode, but vehicle occupancy is necessary to estimate a passenger mode-share distribution. If not estimated through an O&D survey, manual counts can be conducted before and after implementation of a strategy. Manual vehicle occupancy counts can be conducted through observations—personnel with handheld computer devices or clipboards stationed at different points on the roadway and terminal curbsides, counting occupants or numbers of passenger entries and exits per vehicle by vehicle classification. This count should be conducted as part of the vehicle classification count. Commercial vehicle operators could be recruited to keep a log of the numbers of passengers per vehicle during the same time period.

Enplaned O&D Passenger Activity

Enplaned O&D passenger activity for the periods before and after the strategy was implemented, preferably on a monthly basis, should be obtained and used to normalize changes in parking activity and changes in the use of other ground access modes.

Measuring Effects of Parking Strategies

Using the data sources identified in the previous section, this section describes ways to measure changes in parking and ground access behavior following the implementation of strategies to address constrained public parking. Often an airport operator will adopt more than one strategy to address parking constraints, so the resulting changes in behavior will be difficult to attribute to an individual strategy; therefore, it may be sufficient to quantify whether a combination of strategies achieved the desired changes.

The airport environment is complex and, as discussed in the previous section, parking and ground access activity are dependent on many factors. Changes in activity following the implementation of strategies to address constrained parking may indicate their effectiveness or ineffectiveness when, in reality, other factors also influenced the outcome, thereby tempering the effects of the strategies. If the airport operator wishes to understand the cause and effect of strategies rather than just overall changes in activity, information on other factors that may have influenced the rates of change in activity should be considered, such as local or national economic conditions, introduction of low-cost airline service, changes in pricing, or supply of other modes, including privately operated parking and HOV modes, and other factors.

The strategies described in Chapter 5 for addressing ongoing parking constraints will have varying levels of effectiveness in balancing demand with supply when applied at a given airport, depending on the circumstance and how the strategy is formulated and applied. The primary goal and measure of the success of a strategy or strategies is the resolution of the parking constraint. However, it is likely that the strategies will result in other outcomes that affect airport operations and that may not be acceptable to the airport operator, or that may be inconsistent with the goals and objectives for the ground access program or the airport. In other words, in solving the constrained parking problem, another problem may be created. Changes in activity and related impacts that are a logical consequence of implementing strategies to address ongoing parking constraints include the following impact categories:

- Public parking activity,
- Financial performance,
- Vehicle traffic volume,
- Emissions generated,
- Mode-share distribution, and
- Customer service.

Potential impacts specific to each strategy were described in Chapter 5 in the discussion of considerations. Approaches for measuring the changes in activity by impact category are presented in the remainder of this chapter. The airport operator should consider how changes in each category relate to the goals and objectives for the parking program, and with the airport's guiding principles, to determine the acceptability of the strategies implemented.

It can be expected that some strategies may have a more dramatic short-term impact as customers are introduced to the change, and a lesser impact as customers become accustomed to the change. It is recommended that activity data be collected and compared for a minimum of 1 year prior to the change and 1 year following the change to understand short-term impacts and how behavior reaches equilibrium over time. By continuing to compare activity beyond the first year after the change, the airport operator can monitor the ongoing effectiveness of the strategy. Similar time periods should be selected in the before-and-after comparisons. Increments of time that are meaningful for comparison will depend on the constrained parking situation, but monthly, quarterly, and annual increments may be useful to evaluate. For example, if a reallocation of parking and the introduction of a new parking product were introduced at an airport in June 2005, it would be prudent to compare monthly parking activity from July 2004 through June 2005 to parking activity from July 2005 through June 2006, as well as changes in airline passenger activity during those periods. Data on changes in parking activity for July 2006 through June 2007, normalized for changes in airline passenger activity, would provide insight into the ongoing effectiveness of the strategies. Financial data should be collected for the same time periods to measure financial impacts. For vehicle traffic impacts, less data may be available, but the time periods compared should be similar for the before-and-after periods to ensure valid comparisons.

Public Parking Activity

The primary goal of strategies to address constrained public parking is to reduce or resolve the parking constraints. Analysis of parking activity data will reveal whether changes resulted following the implementation of a particular strategy. This analysis is accomplished through a comparison of parking activity before and after the implementation of strategies for similar periods for the total public parking system and by facility or product, while paying particular attention to periods that were typically constrained.

The following benchmarks are useful in this comparison, and all should be evaluated in the context of changes in airline passenger activity and other factors that may influence passenger parking behavior beyond the specific strategy or strategies an airport operator has implemented.

- **Vehicle exits**—A change in the numbers of vehicles exiting the parking facilities, in total, in specific facilities, or between facilities, indicates that the strategy implemented may have influenced passenger choice of parking facilities, or the decision to use parking facilities.
- **Average vehicle length of stay**—A change in the average vehicle length of stay within a facility or complementary changes among facilities indicates that the strategy implemented may have influenced passenger choice of parking facilities. For example, a strategy may be implemented to discourage long-term parkers' use of a facility designated for short-term parking. A decrease in the average length of stay in that facility would indicate that the use of the facility by long-term parkers was influenced by the strategy (or potentially by other factors). Furthermore, similar analysis of average length of stay in other parking facilities may indicate which facility the long-term parkers were diverted to, or if they are no longer using public parking.
- **Vehicle length-of-stay distribution**—Similar to the average length of stay analysis discussed above, a more detailed analysis of the length of stay distribution may provide more insight into parkers' behavioral changes within a facility and between facilities.
- **Facility occupancy**—A comparison of percent occupancy of parking facilities during overnight and peak periods before and after implementation of a strategy provides an indication of parkers' behavioral changes within a facility and between facilities. This information also can supplement and help support conclusions drawn from length-of-stay data.
- **Amount and duration of overflow parking used**—A comparison of the number of times overflow parking was used, the duration of its use, and number of parkers using the overflow parking facility before and after implementation of the strategy provides an indication of whether the strategy minimized (or eliminated) the times that an airport parking system is in overflow condition.
- **Level and duration of additional resources deployed**—A comparison of resources deployed (e.g., extra staff, temporary shuttle services) to manage parking constraints from before and after the implementation of a strategy provides an indication of whether the strategy minimized (or eliminated) the amount of time that an airport experiences constrained parking conditions.
- **Number of parking facility closures**—A comparison of the number of times or the durations of parking facility closures before and after the implementation of a strategy provides an indication of whether the strategy minimized (or eliminated) the times that a parking facility reaches capacity.

Financial Performance

Changes to gross parking revenue and net parking revenue will affect the airport operating environment. Public parking revenue is a significant source of nonaeronautical revenue at most airports because it often generates revenue in excess of cost. Portions of the net revenue from public parking may be used to cover other airport expenses, lower airline rates, or factor into calculations for airport financing for capital programs.

A common problem for the airport operator is to resolve constrained parking while minimizing the financial impact of implementing the strategy to relieve constrained parking. Scenarios that could result in an unacceptable loss of revenue from unanticipated consequences may include the following:

- Loss of public parking customers to privately operated off-airport parking facilities;
- Shift of public parking customers from higher priced public parking to lower priced public parking;
- Shift from public parking to other access modes, such as curbside pickup and drop-off by private automobile, taxicab, and transit; and
- Construction of a new public parking facility (e.g., a parking garage) resulting in substantially more capital costs or operating costs that are not offset by a corresponding increase in parking revenue.

Overall changes in gross parking revenue and net parking revenue will be the most important benchmarks for the airport operator, and should be evaluated in conjunction with changes in parking activity, as described above, and other factors that may have influenced changes in behavior. Changes in revenue for the period before and after the implementation of strategies should be compared to changes in numbers of airline passengers and changes in rates or available parking supply at a certain rate level. Additional financial metrics to consider and evaluate include the following:

- **Gross revenue per space or gross revenue per exit or transaction**—Comparison of changes in revenue generated per parking space or per exit provides an understanding of changes on a unit basis for total parking activity and by facility.
- **Net revenue per space or net revenue per exit or transaction**—Comparison of total net revenues of capital and operating costs to adopt the strategies and manage constrained parking prior to strategy implementation can be

used to understand the financial effects of a strategy on a unit basis for total parking activity and by facility.

- **Gross revenue by facility or parking product**—Revenue by facility or parking product should be compared to changes in parking activity and O&D passenger activity to understand the relationship between changes in activity and revenue. For example, in a particular public parking facility, parking exits may have decreased 2%, and revenue may have increased 4%, while O&D passenger activity increased 1%. These results would be compared to similar changes in other public parking facilities, and for the total parking supply, to understand the influence of the strategy on financial performance and if the financial and activity changes are acceptable. If the strategy implemented is a rate change, the data also can be used to develop parking elasticities.
- **Gross revenue by facility or parking product by duration**—Revenue by duration is useful when determining if a new parking rate schedule was successful in changing parking behavior for defined durations. For example, long-term parkers at an airport may be using short-term facilities, spaces for people who desire to park for less than an hour. To remedy this, the airport operator may have increased the rates for parking in the facility for more than 6 hours to a significantly higher rate than the daily rate in the long-term parking facility. By analyzing parking revenues by duration, the airport operator can determine if the strategy implemented to discourage long-term parkers using the short-term facility has been effective and if the strategy has resulted in a change in the revenue streams for the facility. If applied across all parking facilities, the analysis of revenue by facility by duration can be used to understand the financial impact of the strategy for all parking products. For each length-of-stay category by facility, a comparison of the contribution of each category to revenue and to activity allows an understanding of which users have the greatest effects on financial performance and facility use.
- **Net revenue by facility or parking product**—A comparison of revenues net of capital and operating costs to adopt the strategies and to manage constrained parking prior to and following strategy implementation sheds further light on the revenue analysis discussed above, and allows the airport operator to evaluate the overall financial effect of the strategy compared to changes in parking activity.

If unacceptable changes in revenue can be isolated to users exhibiting certain characteristics or to a specific parking product, this may provide the information the airport operator needs to modify the strategy to lessen the revenue impacts, or the airport operator may decide to reverse the strategy and try a different approach to address the parking constraints.

Vehicle Traffic Volume

Airline passenger airport access and egress trips affect the flow of vehicle traffic on the airport roadway system and terminal curbside, the roadway system surrounding the airport, and the regional roadway system. A relationship exists between constrained public parking and airline passenger shifts to other modes, particularly other single-party modes that offer the customer a door-to-door experience between the trip origin or destination in the region and the airport. Shifts between public parking and other modes affect vehicle traffic volumes. Strategies to resolve constrained public parking could improve vehicle traffic flows on the airport and in the region if trip volumes were reduced. Conversely, vehicle traffic would worsen if strategies increase trip volumes.

Airline passengers shifting from parking for the duration of their trips to being picked up and dropped off by single-party modes contribute to an increase in trip volumes. Airline passengers shifting from single-party modes to high-occupancy modes, such as buses and shared-ride vans, contribute to a decrease in trip volumes.

Single-party modes that the long-term parker may consider for airport access in a constrained parking environment typically include the following pickup and drop-off options:

- Private automobile,
- Taxicab, and
- Single-party limousine.

Nonresident airline passengers may consider shifting between pickup and drop-off by private automobile, taxicab, single-party limousine, and rental car.

Table 27 describes the characteristics of enplaning passengers' airport access trips by mode, including the number of vehicle trips generated to and from the airport for the trip. For example, the long-term parker that shifts to being picked up and dropped off by private automobile for future airline trips is generating twice the number of vehicle trips than were generated when the vehicle was driven to the airport and parked for the duration of the trip. For the enplaning passenger party that is being dropped off by private automobile, two one-way vehicle trips are generated (i.e., the driver drops off the passengers at the terminal and departs the airport without the airline passengers). Another round trip must be made to pick up the passenger party upon its return. The number of vehicle trips generated by a long-term parker that shifts to the taxicab or single-party limousine mode also will increase, because not all taxicabs and single-party limousines transport passengers both to and from the airport during the round trip.

Using the logic from Table 27, Table 28 shows the general changes in vehicle traffic volumes due to shifts between modes.

If trip volumes increase and vehicle traffic becomes congested (or more congested) following the implementation of

Table 27. Typical vehicle traffic impacts of access modes transporting enplaning passengers to an airport.

Mode	Travel Parties Served	Airline Passenger Vehicle Occupancy[1]		Vehicle Trips Generated		Curbside Drop-off?
		Trip to Airport	Trip from Airport	Per Enplaning Travel Party	Per Enplaning Airline Passenger	
Private Automobile Drop-Off (Curbside Only)	Single	Travel Party Size	0	2	2 ÷ Party Size	Yes
Private Automobile Drop-off (Short-Term Parker)	Single	Travel Party Size	0	2	2 ÷ Party Size	Potentially[2]
Long-Term Parker (Terminal Area)	Single	Travel Party Size	Not Applicable[3]	1	1 ÷ Party Size	Unlikely
Long-Term Parker (Remote, On- or Off-Airport)	Single	Travel Party Size	Not Applicable[3]	1	1 ÷ Party Size	Potentially[2, 4]
Rental Car	Single	Travel Party Size	Not Applicable	1	1 ÷ Party Size	Potentially[2, 4]
Taxicab	Single	Travel Party Size	0 or Party Size of New Party[5]	1 or 2[6]	(1 or 2)[6] ÷ Party Size	Yes
Single-Party Limousine	Single	Travel Party Size	0 or Party Size of New Party[5]	1 or 2[6]	(1 or 2)[6] ÷ Party Size	Yes
Shared-Ride Van	Multiple	Total Airline Passengers Served	0 or Total Airline Passengers Served[5]	(1 or 2)[6] ÷ Number of Travel Parties Served	(1 or 2)[6] ÷ Airline Passengers	Yes
Bus (Transit or Privately Operated)	Multiple	Total Airline Passengers Served	Total Airline Passengers Served	1 ÷ Number of Travel Parties Served	1 ÷ Airline Passengers	Yes
Subway or Light Rail to Terminal	Multiple	Total Airline Passengers Served	Total Airline Passengers Served	0	0	No

Notes:

[1] Excludes vehicle occupants who are not enplaning passengers (e.g., well-wishers).

[2] Drivers may drop off some or all of the passenger party members at the curbside before proceeding to parking.

[3] Vehicle does not depart from the airport until the enplaning travel party returns from airline travel. At that time, occupancy is equal to travel party size for the deplaning trip.

[4] Consider trips associated with shuttle drop-off of passengers at the curbside. Shuttle trips are designed to serve multiple travel parties.

[5] Mode may transport new deplaning passengers from the airport. The proportion of trips for taxicabs, limousines, and shared-ride vans that transport airline passengers on both access and egress trips versus those that transport airline passengers on one of the trips (access or egress) should be considered. Empty trips are less likely for shared-ride vans than for taxicabs and single-party limousines because of the business model of shared-ride van operators.

[6] Two trips if the vehicle departs the airport without airline passengers and one trip if the vehicle returns to a staging area prior to returning to the curbside to pick up a deplaned passenger for an outbound trip.

Source: Ricondo & Associates, Inc., and DMR Consulting, November 2, 2009.

Table 28. Directional changes in vehicle trip generation from mode shifts resulting from constrained airport parking.

	Current Mode						
Previous Mode	Private Automobile (Pick Up and Drop-Off)	Private Automobile (Long-Term Parker)	Rental Car	Taxicab	Single-Party Limousine	Shared-Ride Van	Bus, Light Rail, Subway
Private Automobile (Pickup and Drop-Off)		Decrease	Decrease[1]	Decrease	Neutral or Decrease	Decrease	Decrease
Private Automobile (Long-Term Parker)	Increase		–	Increase	Increase	Decrease	Decrease
Rental Car	–	–		–	–	–	–
Taxicab	Increase	Decrease	–		–	–	–
Single-Party Limousine	Neutral or Increase	Decrease	–	–		–	–
Shared-Ride Van	Increase	Increase	–	–	–		–
Bus, Light Rail, Subway	Increase	Increase	–	–	–	–	

Notes:

– Mode shift unlikely to occur as a result of constrained parking or implementation of strategies to address constrained parking.

[1] Shift primarily applies to nonresidents.

Source: Ricondo & Associates, Inc., and DMR Consulting, November 2009.

strategies, airport operations personnel will have a general feel for the magnitude of the impacts. Some changes may be more pronounced in the short-term and become less noticeable after customers become accustomed to the strategies. If trip volumes decrease and vehicle traffic flow improves, the airport operator may still wish to understand the reasons for the shift. At many airports, the airport operator is accountable to the surrounding communities for the impacts generated by airport activity, and information on the changes in impacts would be useful.

Benchmarks that can be compared over similar timeframes before and after the strategies have been implemented to assess the impacts of the strategies on vehicle traffic include the following:

- **Number of total parking exits**—A change in total vehicle parking exits without a comparable change in total airline passengers (after accounting for seasonality) indicates that passengers have likely shifted to or from other modes, or the average occupancy per vehicle (party size) has changed. For example, if the party size has not changed and the number of airline passengers has not changed, but total vehicle parking exits have increased, customers have shifted to use of the parking facilities from curbside pickup and drop-off by private automobile and from other modes. Conversely, if vehicle exits have decreased without changes in party size and passenger numbers, customers have shifted to curbside pickup and drop-off by private automobile or other modes. In analyzing these data, it is important to recognize that mode shifts and resulting parking characteristics change seasonally; therefore, care should be taken to normalize the data to isolate the reasons for the change.
- **Number of exits by parking facility**—A shift in vehicle parking exits from one parking facility to another also will have vehicle traffic implications. For example, customers shifting from terminal area parking to remote parking may result in an increase in the number of parking customers dropping off members of their travel party at the terminal curbside before driving to the remote lot. This results in additional vehicle traffic at the terminal curbside.
- **Private automobile activity on the airport roadway system, at terminal curbsides, and in cell phone lot**—An increase in private automobile activity at the terminal curbsides indicates an increase in the pick up and drop-off mode, or an increase in drivers dropping off travel party members prior to parking their automobiles for the duration of the airline trips. This analysis should be considered in conjunction with vehicle exit and length-of-stay distribution data from the parking revenue control system.
- **Changes in taxicab and limousine activity**—Changes in taxicab and limousine activity provide additional insight into modes to which parking customers may have diverted.
- **Airline passenger mode choice distribution**—A comparison of mode share by the four primary passenger market segments—resident business, resident nonbusiness, nonresident business, and nonresident nonbusiness—will

provide additional insight into mode choice. Mode share for all O&D passengers can be used to estimate access trips to and egress trips from the airport. To gain an understanding of the nature of the changes in overall mode share, the analyst must review the changes in the proportion of resident and nonresident airline passengers and business and nonbusiness airline passengers to determine if overall changes in mode share were caused by shifts in the proportion of user groups or changes in mode preference among user groups.

Vehicle trips for single-party modes can be estimated by applying the mode-share data to a count of O&D passengers, such as average daily O&D airline passengers. Trips generated by other modes, such as shared-ride vans and scheduled HOV modes, can be obtained from data sources maintained by the airport operator, such as the AVI system, trip dispatch logs, or published schedules. However, the number of scheduled HOV trips is unlikely to change as a result of parking strategies implemented, unless it was part of the strategy. The number of shared-ride vans may change as a result of shifts to or from the private automobile.

Changes in vehicle trips by passengers being picked up and dropped off by private automobile, taxicab, and single-party limousine will represent a similar change in vehicle trips at the terminal curbside, with the exception of recirculating trips.

Vehicle trips can be estimated for each of the single-party passenger modes using Equation 1. The data for the calculation often are obtained from O&D passenger surveys. Since the time interval between administration of O&D surveys will often be 3 or 4 years, any changes in parking and ground access patterns will likely be influenced by multiple factors during the elapsed time. Therefore, changes in mode share may be caused by factors in addition to, or other than, the strategies implemented to address constrained parking. Conversely, if mode shares did not change, it may be because of factors in addition to, or other than, strategies implemented to address constrained parking.

The calculation of vehicle trips generated by single-party modes at an airport is shown in an example presented in Table 29.

$$V_{XZ} = (((Y_Z * M_X) \div P_X) * T_X) * 2 \qquad \text{(Equation 1)}$$

where

V_{XZ} = Total estimated vehicle trips generated by mode X for period Z.
Y_Z = Enplaning O&D passengers for period Z (for example, average day, peak day average month, annual).
M_X = Mode-share percentage for mode X.
P_X = Average party size for mode X.
T_X = Average vehicle trips per enplaning passenger trip. Includes the trip to the airport plus average empty trip rate. For long-term parkers, the empty trip rate is 0. For drop-off by private automobile, the average empty trip rate is 1, as all such automobiles depart from the airport without members of the enplaning passenger party. For taxicabs and limousines, the rates will typically be between 0 and 1. Airline passenger survey data, as well as dispatch information and information about vehicle regulations, will assist the airport operator in determining the empty trip rate.

Explanation:

$Y_Z * M_X$ = Estimated enplaning O&D passengers using mode X for time period Z;
$((Y_Z * M_X) \div P_X)$ = Estimated number of automobiles carrying enplaning O&D

Table 29. Example calculation of vehicle trips for single-party passenger modes.

Single-Party Mode (X)	Mode-Share Percentage (M)	Average Party Size (P)	Vehicle Trips per Enplaning Passenger Trip (T)	Calculation ((((Y$_Z$ * M$_X$) ÷ P$_X$) * T$_X$) * 2)	Total Estimated Average Daily Vehicle Trips (V)
Private Automobile (Pick Up and Drop-Off)	32%	2.1[a]	2.0	(((17,400 * .32) ÷ 2.1) * 2) * 2	10,606
Private Automobile (Long-Term Parker)	19%	1.4[b]	1.0	(((17,400 * .19) ÷ 1.4) * 1) * 2	4,723
Rental Car	21%	1.8[a]	1.0	(((17,400 * .21) ÷ 1.8) * 1) * 2	4,060
Taxicab	11%	1.3[a]	1.5	(((17,400 * .11) ÷ 1.3) * 1.5) * 2	4,417
Single-Party Limousine	6%	1.6[a]	1.8	(((17,400 * .06) ÷ 1.6) * 1.8) * 2	2,349

Notes:

(Y$_Z$)—17,400 average annual daily enplaning airline passengers for Year Z.

[a] Average party size for this mode does not include the driver of the vehicle.

[b] Average party size for this mode includes the driver of the vehicle.

Source: DMR Consulting, November 2009.

passengers using mode X for time period Z; and

$(((Y_Z * M_X) \div P_X) * T_X)$ = Estimated number of vehicle trips generated by enplaning O&D passengers using mode X for time period Z, including empty trips.

Multiply the above by 2 to estimate the number of vehicle trips generated by enplaning and deplaning O&D passengers, assuming enplaning and deplaning trip behavior is generally the same.

VMT is another measure of the effects of airport trips generated by airline passengers. Vehicle miles traveled for the periods before and after the parking strategies were implemented can be calculated based on the data from O&D surveys on local trip origins and the total trips estimated following the example calculation shown in Table 29 for an enplaning passenger. A private automobile drop-off trip from a point of origin 20 mi from the airport generates 40 VMT in the region and a drop-off trip from a point of origin 35 mi from the airport generates 70 VMT. To calculate the change in VMT from shifts in the mode-share distribution following implementation of parking strategies to relieve parking constraints, a simple assumption would be to apply the average distances traveled from the O&D airline passenger survey by mode to the changes in the numbers of private automobiles that are parked for the duration of the airline passenger's trip and used for picking up and dropping off passengers, as well as taxicabs and single-party limousines. For private automobiles picking up and dropping off passengers, and the other on-demand modes, the average number of empty trips must be factored into the calculation (as shown in Equation 1 and Table 29).

Changes in airline passenger activity should be factored into the analysis to normalize the results and help ensure that the results of the strategy are not skewed based on fluctuations in the numbers of airline passengers.

Emissions Generated

The change in emissions generated on the airport, in the vicinity of the airport, and in the region by automobiles transporting airline passengers to and from the airport as a result of strategies implemented to address constrained airport parking may be a consideration for the airport operator when determining the acceptability of a strategy.

The VMT can be used along with information about pollutants emitted by vehicles in the airport's catchment area to determine the changes in environmental impacts. A data source for estimating vehicle emissions is the Emissions and Dispersion Modeling System (EDMS), a model approved for use by the FAA and EPA for estimating the air quality impacts of airport emissions sources, including ground access vehicles. (*23*) In EDMS, vehicle emissions factors are estimated from the latest version of the EPA's mobile source emissions model.

Mode-Share Distribution

The airport operator may be concerned about how strategies implemented to address constrained parking affect the mode-share distribution of airline passengers, particularly if the use of HOV modes is encouraged. Information from an O&D airline passenger survey from before and after the parking strategies have been implemented is the best source for keeping track of airline passenger mode-share distribution, and should be evaluated in total and for the four airline passenger market segments, as described earlier in the section on "Vehicle Traffic Volume."

Customer Service

The customer service implications of strategies implemented to address constrained parking will be of concern to the airport operator. If the primary intent of implementing the strategies is accomplished (improving or resolving constrained parking), it would seem that more customers would be pleased or fewer would be displeased. Strategies aimed at resolving the problem for some users may create inconveniences for others. This inconvenience will be evident from changes in parking activity, increased vehicle traffic, or decreased revenue. Changes in the customer service category are more difficult to measure than changes in other categories. One indication of a change that affects customer service is if the airport operator receives more complaints following the implementation of strategies. At some airports, customer satisfaction surveys are administered on a regular basis. If questions are included related to the availability of parking, pricing, and other factors, as well as questions on other access modes, this information should be compared for similar periods before and after strategies are implemented.

CHAPTER 9

Strategies to Address Constrained Employee Parking

Through the research conducted under ACRP Project 10-06, few instances of constrained employee parking at an airport were identified. Of the airports that experienced constrained employee parking, the constraints were resolved relatively quickly compared to public parking constraints, and considered easier to resolve by airport operators than were public parking constraints. Employee parking constraints were resolved primarily by adding capacity. Airport operators typically have more options available for the accommodation of employee parking and, compared to airline passengers accessing the airport, airport employees typically have fewer alternative access mode options available to them.

The characteristics of the employee commute to an airport, the strategies airport operators may consider adopting to manage or resolve constrained employee parking, and ways to evaluate the effectiveness of the strategies are presented in this chapter.

Airport Employee Commute Environment

Airport employees are defined as employees of the airport operator, airline tenants, or other businesses located on the airport property. Employee commute trips account for a sizable number of daily vehicle trips generated by a commercial airport. The number of airport employees and their commute patterns are the primary determinants of the demand for employee parking and, therefore, will provide insights into employee parking constraints. For a description of employee customer segments, please refer to Chapter 1.

Each employee commuting in a single-occupant automobile needs a parking space in the vicinity of the airport for the duration of the work shift. At some commercial airports, parking is offered to employees for a low monthly fee that is often less than the price of a monthly transit pass, or the parking is subsidized by employers. Low-cost parking may serve as a disincentive for commuting by transit or ride-sharing by airport employees.

Often, the public transportation system serving an airport does not adequately serve all work shifts. Most medium- and large-hub airports operate on a 24-h per day schedule, 365 days per year; however, public transportation systems often do not operate on a 24-h schedule, and public transportation service schedules are designed to accommodate peak commute times of the traditional office worker (approximately 7 A.M. to 9 A.M. and 5 P.M. to 7 P.M.), which are not the same as the peak times for airport shift workers.

Of the access mode choices available to the airline passenger, most are not an option for the airport employee because of the limited service availability to key on-airport employment areas or the prohibitive cost as a routine commute option. Table 30 shows the applicability of potential access modes as employee commute options.

Strategies to Address Constrained Employee Parking

Strategies to manage or resolve constrained employee parking include increasing capacity, improving the use of existing facilities, and offering alternatives to the drive-alone commute.

Potential outcomes from each of the strategies to resolve constrained employee parking are similar to those described for public parking constraints in Chapter 5—an airport operator should consider the financial, vehicle traffic, environmental (vehicle emissions), and customer service implications of each strategy. For example, a strategy may have a financial implication resulting from changes in revenue, capital, or operating costs. Each strategy may result in a change in vehicle trips generated to and from the airport or trip patterns on the airport roadway system, and this may produce related changes in vehicle emissions. The customer service implications of each strategy should also be considered for both employees and their employers.

Table 30. Airline passenger access mode applicability for the employee commute.

Access Mode	Applicability for Employee Commute
Private Automobile: Drive and Park	Preferred mode at many airports (typically as a single occupant)
Private Automobile: Dropped Off and Picked Up	Unlikely
Rental Car	Cost prohibitive (and requires a parking space)
Taxicab	Cost prohibitive
Single-Party Limousine	Cost prohibitive
Shared-Ride Van	Cost prohibitive
Privately Operated Bus	Cost prohibitive without employee discounts
Public Transportation	Use depends on schedules, geographic coverage, and relative cost compared to parking

Source: DMR Consulting, November 2009.

Increase Capacity

An airport operator may increase the employee parking supply to accommodate demand either through the addition of permanent spaces or the temporary reallocation or reassignment of another parking facility or available parcel of land to employee parking on an as-needed basis.

Consolidate the Parking Supply

If an airport's employee parking supply is provided in more than one location, the airport operator may consolidate some, or all, of its employee parking supply. The purpose of this strategy is to improve the use of employee parking facilities and reduce operating costs (e.g., shuttle busing, access control) associated with serving multiple parking facilities. This strategy should be considered if better facility use or cost savings could be achieved by consolidation.

Reassign Parking Facilities

If an airport's employee parking supply is provided in more than one location and some facilities are constrained while others have excess capacity, an airport operator can reassign parking facilities among employees to balance facility demand. For example, employees who use a constrained facility could be reassigned to an unconstrained facility. Alternatively, all employees could be reassigned to balance parking facility use. In reassigning parking facilities, the airport operator may consider the proximity of employee parking to employee work locations to ensure the efficiency of transportation (if shuttle bus service is required) between work locations and parking facilities.

Adjust Parking Rates

An airport operator may adjust parking rates in an attempt to balance demand among facilities if the airport employee parking supply is provided in more than one location and some facilities are constrained while others have excess capacity. Rates would be adjusted so that the constrained facilities are priced higher than the unconstrained facilities to provide a price differential as a disincentive for parking in the constrained facility. Consideration might be given to how parking rates in each facility relate to the price of a monthly transit pass, if transit is a viable commute option for employees.

Employee Parking at McCarran International Airport

Over 20,300 employees work at McCarran International Airport (LAS), which includes 1,200 employees in the Clark County Department of Aviation (the operator of LAS). The Department of Aviation provides a total of 3,800 parking spaces for employees. The employee parking system is constrained at LAS. Approximately 3,250 of the spaces dedicated for employee parking are provided in Terminal 1 and the remainder of the available employee parking spaces is provided in Terminal 2. The Department of Aviation addresses the constraints by making use of its ample passenger economy lot for employees if needed. Employees using the public lots are charged a reduced rate. (*3*)

Adjusted Employee Parking Rates at Tulsa International Airport

Approximately 2,000 employees work at Tulsa International Airport, including 170 Tulsa Airport Authority employees. Airport employee parking is provided in two dedicated lots with a combined inventory of 471 spaces. The A Lot has 248 spaces, and the B Lot has 223 spaces.

The B Lot was experiencing constraints because of its proximity to TSA offices, and the A Lot had excess capacity. In 2007, the Authority Board instituted differential pricing for the two lots to balance demand between the two facilities. Employees in the B Lot pay $22.50 per month and employees in the A Lot pay $15.00 per month. The strategy has been effective in shifting demand from the B Lot to the A Lot. (*15*)

Offer Alternatives to the Drive-Alone Commute

Successful alternative access modes to the drive-alone commute mode will reduce the need for employee parking spaces. However, a significant challenge to airport operators who are considering ways to reduce single-occupant employee trips is that they often only have the authority and the ability to set policies for their own employees. Because employees of the airport operator typically account for a comparatively small share of the total airport employee population, the effectiveness of any policies implemented to encourage the use of other access modes may be limited. Table 31 shows that for the representative airports participating in ACRP Project 10-06, employees of the airport operator typically account for less than 10% of the total employee population at the airport.

Table 31. Airport operator employee share of the total airport employee population.

Airport	Total Airport Employee Population	Airport Operator Employees	Airport Operator Share of the Total Airport Employee Population
Large-Hub Airports			
Boston Logan International (BOS)	14,000	800–900	6%
Chicago O'Hare International (ORD)	50,000	1,500[a]	3%
McCarran International (LAS)	20,350	1,200	6%
Miami International (MIA)	35,000	–	–
San Diego International (SAN)	5,000–6,000	335	6%
Seattle-Tacoma International (SEA)	22,000	833	4%
Tampa International (TPA)	6,500	625	10%
Washington Dulles International (IAD)	18,800	–	–
Large-Hub Average			**5%**
Medium-Hub Airports			
Bob Hope (BUR)	1,900	120	6%
Oakland International (OAK)	10,000	–	–
Port Columbus International (CMH)	3,500	360	10%
Portland International (PDX)	11,000	300	3%
San Antonio International (SAT)	440	–	–
Medium-Hub Average			**5%**
Small-Hub Airports			
Huntsville International (HSV)	550	105	19%
Tulsa International (TUL)	2,000	170	9%
Small-Hub Average			**11%**

Notes:

– Data not available.

[a] The number of airport operator employees shown for Chicago O'Hare International Airport includes employees at both O'Hare and Midway International Airports.

Source: Ricondo & Associates, Inc., and DMR Consulting, based on airport case studies (November 2008 through February 2009). (*1–15*)

Transportation Management Association, Massachusetts Port Authority

The Massachusetts Port Authority founded a transportation management association at Boston Logan International Airport (BOS) in 1997. The purpose of the TMA is to reduce single-occupant employee commute trips to BOS, reduce the demand for employee parking, and improve commuting options for employees using alternative modes of transportation. Employees of participating employers receive discounts on the Logan Express, a network of regional nonstop express buses sponsored by Massport, and on some of the privately operated scheduled HOV services. These employees also receive ride-matching services and information on alternatives to commuting alone. The TMA introduced a commuter cash program to its members in 2007. Member employees who switch from driving alone to carpooling, bicycling, walking, or using public transportation receive $3 per day. Massport provides a 50% subsidy, up to $100 per month, to its employees who commute using the Logan Express or public transportation. (*1*)

Strategies that may be implemented to influence employee use of alternative access modes are described in the remainder of this section and summarized in Table 32. The strategies may be sponsored by (1) the airport operator for its employees or for a larger population of airport employees, (2) other airport employers for their employees, or (3) a transportation management association (TMA).

Transportation Management Association

The airport operator or other airport employers may form a TMA, which is an association of employers working together to provide information and offer incentives to employees to encourage the use of an alternative access mode to the single-occupant automobile. The TMA may sell and distribute transit passes, such as at an employee commute store that would also provide information on ride-sharing and HOV commute options. The TMA may maintain a website to provide information on the program to its members. Each member employer may pay membership dues to fund the operation of the TMA. TMA operation may include a salary for a transportation management coordinator who works with member employers and their employees. Individual employers may also have a transportation management coordinator to serve as a

Table 32. Strategies to reduce the drive-alone employee commute.

Strategy	Description
Transportation Management Association	Develop an association of employers that provides information and incentives to employees on alternatives to the drive-alone commute.
Commute Options Outreach	Provide information on a website about transportation program options and information packets or presentations to new employees.
Carpool Program	Support carpooling by offering discounted parking permits or other incentives, preferential parking, or ride-matching services to pair up commuters from similar origins.
Vanpool Program	Provide vans or other incentives for employees that form vanpools.
Public Transit Subsidies	Subsidize public transit fares. Offer additional benefits such as free fares for a defined period for those employees who relinquish their parking passes.
Enhanced Transit Service	Work with transit operator to provide service that better accommodates employee work schedules or provide subsidy or initiate service.
Shuttle Service	Provide a shuttle service to communities with significant employment populations or from the point served by public transportation to other airport employment locations. This service could supplement public transit during hours when transit service is not available.
Discounts on Private HOV Services	Offer discounts on privately operated HOV services.
Emergency Ride Home	Offer a defined number of taxicab or rental car vouchers for employees who use an alternate mode for emergency use or as a contingency for overtime.
Compressed Work Week	Provide the option of working a compressed work week to eliminate a commute trip. For example, employees may work 80 h over a 2-week period in 8 or 9 days rather than 10 days.
Car Sharing	Provide space for a car-sharing program and offer car-share incentives (such as a couple of hours of free use per month) to those employees who use alternative travel modes for their commute.
Bicycle Racks	Provide bicycle racks to promote bicycling as an alternative mode; however, this is not a viable mode in many airport environments.

Source: DMR Consulting, based on airport case studies conducted for ACRP Project 10-06. (*24–28*)

Reducing the Single-Occupant Commute at San Diego International Airport

San Diego County Regional Airport Authority employees are eligible for a subsidy of half their transit fare. Employees must relinquish their parking passes to receive the subsidy. (*5*)

liaison between its employees and the TMA. Membership may be voluntary, or it may be mandatory through lease agreements between the airport operator and its tenants.

Commute Options Outreach

An airport operator, an individual employer, or a TMA may provide information on a website about transportation program options and information packets or presentations to new employees.

Carpool Program

An airport operator, an individual employer, or a TMA may provide incentives and information about carpooling to airport employees. Carpool program elements may include preferential parking, free or reduced parking fees, and ride-matching services, as well as information and promotions to encourage employees to try carpooling. The airport operator may extend the benefits of the carpool program to all airport employees.

Vanpool Program

An airport operator, an individual employer, or a TMA may provide incentives to employees to form vanpools, including the provision of vans, subsidized fuel, free parking, preferential parking, and vanpool matching. Regardless of who sponsors the vanpool program, participation in the program may be offered to a population of employees that extends beyond those directly employed by the sponsor(s) to ensure a level of participation needed for vanpool formation. Employees not directly employed by the sponsor(s) may pay a higher participation fee than those employed directly by the sponsor(s).

Public Transit Subsidies

An airport operator, an individual employer, or a TMA may subsidize transit passes for its employees to promote increased use of HOV modes. The employer may also provide information on transit options to its employees or customize trip plans.

Enhanced Transit Service

An airport operator or a TMA may work with a transit operator to improve the schedule of the public transportation system to better accommodate employee work schedules. Alternatively, the airport operator or a TMA may provide a transportation service that improves the viability of public transportation commuting for employees.

Shuttle Service

The airport operator or a TMA may provide a shuttle service to communities with significant employee populations that are not served by the public transportation system or that are not

Reducing the Single-Occupant Commute at Seattle-Tacoma International Airport

The Port of Seattle is subject to the state of Washington commute trip reduction law that was enacted in the 1991. Accordingly, the Port offers an employee commute program for its employees. During 2007 and 2008, the Port branded its employee commute program, increased its promotion of the program, and offered a $30 voucher each month to employees who commuted at least 50% of their work days by any HOV mode, including carpools. The voucher was valid for the purchase of goods and services from a variety of merchants in the region, such as retail stores, car washes, and gas stations. As a result, the number of employees buying transit passes doubled, and approximately 70 parking spaces that had been used by employees became available for long-term parking by airline passengers. (*6*)

Reducing the Single-Occupant Commute at Tampa International Airport

The Hillsborough County Aviation Authority is a member of the community initiative that assists employees in locating carpooling alternatives. Scheduled bus service is provided by the Hillsborough Area Regional Transit Authority from Tampa International Airport to the central business district (with numerous transfer options). Additionally, the authority subsidizes 50% of transit fares for its own employees. (*7*)

Transit Service Enhancements at San Francisco International Airport

The City and County of San Francisco Airport Commission subsidizes one bus route serving San Francisco International Airport (SFO), SamTrans 397, to ensure that the airport has 24-h transit service. The subsidy is based on the rides of customers who board and exit the bus at SFO. The route operates through San Mateo and San Francisco counties and serves downtown San Francisco. It is the only bus route in San Mateo County that operates between 2 A.M. and 5 A.M. The Airport Commission was the catalyst for this route, because SFO is the largest employment center in San Mateo County. (*24*)

served for a portion of the employee work schedule. If public transportation serves only the terminal area, and there are airport work sites that support a significant number of employees but are not within walking distance of the terminal area, the airport operator or TMA may provide a shuttle service between the terminal area and other employment locations to make transit a viable option for employees with work sites outside of the terminal area.

Discounts on Private HOV Services

The airport operator, TMA, or private HOV operators may offer discounts on privately operated HOV services to airport employees. The discount may be on a per trip basis, or involve the purchase of a monthly pass or multiple trips to receive the discount.

Emergency Ride Home

For employees who commute to the airport using an HOV alternative to the single-occupant automobile, the airport operator or TMA may offer to reimburse the employee for the cost of a taxicab, public transportation, or a rental car to leave work in an emergency or if the employee must work late unexpectedly. The number of times an employee is eligible for an emergency ride home may be limited.

Compressed Work Hours

Airport employers may offer compressed work schedules for employees to reduce the number of commute trips to the airport. Typical schedules involve working 40 h over 4 days or 80 h over 9 days.

Transit Service Enhancements at San Diego International Airport

In mid-November 2008, the San Diego County Regional Airport Authority initiated free, nonstop bus service between the Old Town Transit Center and San Diego International Airport (SAN) for employees only. The service was operated for a 6-month pilot period, following which funding was extended for another year, through June 2010. Employees traveling from the north using commuter rail, light rail, and public bus service can now travel directly between the Old Town Transit Center and SAN during select hours in the morning and afternoon that are timed with the commuter rail service. Previously, employees had to travel to a train station farther south and farther from the airport to take a public bus that makes multiple stops between the train station and SAN. (*5*)

Car Sharing

An airport operator, a TMA, or another large employer may maintain, or contract for the provision of, a fleet of automobiles for hire by the hour for employees who have a need to leave the airport occasionally. As an incentive, the employer may provide a certain number of rental hours free of charge over a unit of time, such as a quarter, for eligible employees that normally commute using an alternative to the single-occupant automobile.

Bicycle Racks

An airport operator may provide bicycle racks near airport employment locations to promote the use of bicycles as an alternative commute mode to the airport. Bicycling may not be a viable commute option at some airports because of safety issues related to the configuration of the airport roadway system or heavy vehicle traffic.

Evaluating Strategy Effectiveness

Suggested data sources and methods for evaluating the effectiveness of strategies adopted, as well as related impacts, are described in this section.

Data Sources

The following data sources are helpful in gaining an understanding of employee commuting activity and in measuring the effectiveness of strategies. To evaluate the effectiveness of strategies, data should be collected from periods both before and after strategy implementation so that changes in activity can be evaluated to determine whether the implemented strategy achieved the intended result.

- **Employee parking activity**—Employee parking activity can be measured using data obtained by an employee parking access control system, which may include data provided by a card reader system allowing access into the facility or by gate counts. The card reader system or gate counts may provide information on the distribution of vehicles by time of day, and may also calculate occupancy in the parking facility if vehicle entrance and exit data are captured.
- **Vehicle traffic counts**—Using ATRs in the vicinity of entrances or exits to parking facilities will provide information on vehicle activity by time of day if the employee parking access control information or gate counts are not capable of providing this information. Parking shuttles must be factored out of the counts.
- **Occupancy counts**—Counts of the number of vehicles parked in the parking facilities can be collected during peak times, such as during the overlap period between shift changes. This information should be collected before and after strategy implementation to allow an airport operator to understand whether the number of parked vehicles during comparable time periods has changed as a result of strategy implementation.
- **Vehicle occupancy counts**—The average number of employees per vehicle (i.e., vehicle occupancy) can be determined through manual counts at the entrance or exit to employee parking facilities or through counts of employees using shuttle buses serving remote employee parking lots. The vehicle occupancy data should be directly correlated with vehicle traffic counts collected concurrently with the occupancy counts. The evaluation of changes in vehicle occupancy may provide insight into the reasons for changes in parking activity.
- **Employee commute characteristics**—A survey of the entire airport employee population provides information on the distribution of employee commuting by time of day and day of week, employee residences within the region, commute mode, vehicle occupancy, demographic information, employer, job type (i.e., shift worker, administrative worker, flight crew), and other information essential to understanding commute patterns. If an employee commute survey is conducted at regular intervals, it can be used to measure before-and-after behavior subsequent to implementation of a strategy, recognizing that other changes may have occurred during the period between surveys that also may have affected travel behavior. It is important for questions and answer choices to be similar each time the survey is administered so that the results from survey to survey can be compared. Individual employers may also conduct such a survey to develop commute strategies for their own employees, but it will not provide the information necessary for the employer to determine if partnering on strategies with other employers is viable.
- **Parking permits**—A database of parking permits issued by the airport operator provides information on the number of employees with parking privileges, by location of the parking facility, and perhaps by employer, but does not provide information on how often or when each employee uses the parking facility.
- **Employee security badges**—A database of employee security badges issued can provide general information on employee residence location by zip code, by employer; however, these data do not provide information on whether or not the employee has a parking permit, or how often or when each employee commutes to the airport. These data are highly confidential, but often can be obtained as a distribution of employees by home zip code and employees by employer, without employee identities.

Measuring Impacts

Using the data sources identified in the previous section, changes in employee parking and commuting behavior following the implementation of strategies to address constrained parking can be measured. If the airport operator adopts more than one strategy to address employee parking constraints, the resulting changes in behavior will be difficult to attribute to an individual strategy; therefore, it may be sufficient to quantify whether a combination of strategies achieved the desired changes.

The airport environment is complex and, as discussed in the previous section, parking and ground access activity is dependent on many factors. Changes in activity following the implementation of strategies to address constrained parking may seem to indicate their effectiveness or ineffectiveness when, in reality, other factors also influence the outcome and temper the effects of the strategies. If the airport operator wishes to understand cause and effect of strategies rather than just overall changes in activity, information on other factors that may have influenced the changes in activity should be considered, such as local or national economic conditions, expansion or reduction of airport activities that led to changes in employment, changes in pricing or supply of HOV modes, and other factors.

Each of the strategies described earlier in this chapter for addressing employee parking constraints will have varying levels of effectiveness in balancing demand with supply when applied at a given airport, depending on the circumstance and how the strategy is formulated and applied. The ultimate goal and measure of success of a strategy or strategies is resolution of the parking constraint. But the strategies will have other outcomes that affect airport operations and may not be acceptable to the airport operator, or may be inconsistent with goals and objectives for the ground access program or the airport. In other words, solving one problem (constrained parking) may create another problem. Changes in activity and related effects that are logical consequences of implementation of strategies to address employee parking constraints can occur in the following categories:

- Employee parking activity,
- Financial performance,
- Activity by mode,
- Vehicle traffic volume,
- Vehicle emissions, and
- Customer service.

Approaches for measuring the changes in activity or effects by category are presented in the rest of this section. The airport operator should consider how changes in each category relate to the goals and objectives for the employee parking program to determine the acceptability of the strategies implemented.

Employee Parking Activity

The ultimate goal of strategies to address constrained employee parking is to reduce or resolve parking constraints. Changes in parking activity are revealed through analysis of parking activity data. The analysis is conducted through a comparison of parking activity before and after the implementation of strategies for similar periods for the employee parking supply, paying particular attention to periods that were typically constrained.

Airport employee parking demands and peaking patterns are typically more uniform on a day-to-day basis than those of public parking demands, which can change dramatically on a day-to-day and seasonal basis. The airport employee population typically consists primarily of hourly shift workers, management staff, and airline employees who work a relatively stable schedule. Although the variable schedules of certain employee groups, such as airline crews, can be directly influenced by changes in airline activity (e.g., O&D passenger activity), the effects of variations in aviation-related activity patterns on overall employee demands are typically moderated on a day-to-day basis, resulting in a relatively stable employee parking demand compared with public parking demand. As a result, employee parking demand is not typically influenced by changes in airline passenger activity to the extent that public parking demand is affected. Therefore, the use of benchmarks equating employee parking demand to changes in airline passenger activity are typically less appropriate than for assessing public parking demand.

The following benchmarks are useful in evaluating the potential effects of a constrained parking solution; however, all should be evaluated in the context of changes in external influences that could affect employee parking activity, such as the effect of the local economy, changes in tenant employee schedules, changes in airline operations that could affect employment, or other factors that may influence employee parking behavior beyond the specific strategy or strategies an airport operator has implemented. Other factors may include changes in cargo activity, changes in the number and characteristics of airlines serving the airport, and other changes in airport tenants.

- **Vehicle exits**—A change in total vehicle parking exits, in specific facilities or between facilities, indicates that the strategy implemented may have influenced employee choice of parking facilities. The change in exits should be normalized by the number of parking permits issued by facility.
- **Parking permits**—A change in parking permits per badged employee may provide an indication of shifts to other modes following implementation of a strategy. If the number of parking permits issued per facility has changed, a comparison of the rate of change in permits to the rate of change in exits and occupancies will help the airport operator under-

stand the effectiveness of the strategy, with the understanding that airline flight crews will generate fewer exits per badge given their work schedules.

- **Vehicle length-of-stay distribution**—If available, these data can provide insight into shift lengths and the proportion of activity generated by flight crews and related changes after a strategy has been adopted.
- **Facility occupancy**—The change in occupancy levels during constrained periods before and after implementation of the strategy is the ultimate measure of the effectiveness of the strategy.
- **Vehicles by time of day**—An analysis of the number of vehicles entering or exiting an employee parking facility by time of day before and after strategy implementation will provide further information on the specific changes that occurred. For example, increased use of HOV modes may have resulted in a decrease in parking activity during the work shifts when the HOV mode was available as an alternative access mode.

Financial Performance

The employee parking operation may be operating at a financial loss to the airport operator. A comparison of financial performance before and after strategy implementation will be important for monitoring changes in financial performance if gross revenue, operating costs, or capital costs have changed.

Activity by Mode

The airport operator may be concerned about how strategies adopted to address constrained employee parking affect the mode-share distribution of employees, particularly if the use of HOV modes is encouraged. Information from an employee commute survey conducted before and after parking strategies were adopted is the best source for keeping track of employee mode-share distribution.

Vehicle Traffic Volume

Employee access and egress trips affect the flow of vehicle traffic on the airport and regional roadway systems. When employee commute choices shift among the single-occupant private automobile, carpooling, vanpooling, and HOV modes, it affects vehicle traffic volumes. Strategies for the resolution of constrained employee parking could improve vehicle traffic on the airport roadways and in the region if the number of vehicle trips decreased. Conversely, vehicle traffic would worsen if strategies increase trip volumes.

Trip volumes are measured using data from traffic counters or entry or exit data from the employee parking access control system, because each entry or exit represents one vehicle trip.

Trips generated by employees using private automobiles may also be estimated using data from the employee commute survey. The employee commute survey will provide employee mode-share distribution data and numbers of employees per vehicle. These data can be used to estimate the number of vehicle trips generated by employees commuting by private automobile. Vanpool trips can be added to the calculation using data maintained by the airport operator, the TMA, or individual employers.

Vehicle Emissions

The change in emissions generated by airport employee commute vehicles on the airport roadway system, in the vicinity of the airport, and in the region as a result of strategies adopted to address constrained parking may be a consideration for the airport operator.

VMT can be used along with information about pollutants emitted by vehicles in the airport catchment area to determine the changes in environmental impacts.

A data source for estimating vehicle emissions is EDMS, a model approved for use by the FAA and EPA for estimating the air quality impacts of airport emissions sources, including ground access vehicles. (*23*) In EDMS, vehicle emissions factors are estimated from the latest version of the EPA's mobile source emissions model.

Customer Service

The customer service implications of strategies adopted to address constrained employee parking will be of concern to the airport operator. Employees and their employers may be affected by different strategies. Strategies intended to resolve problems for some users may create inconveniences for others. Changes in customer service are more difficult to measure than changes in other categories. One indication of changes in customer service is if the airport operator receives an increased number of complaints following the implementation of strategies. The airport operator could administer a customer satisfaction survey before and after implementation of strategies to measure changes in customer satisfaction. It is suggested that the survey include questions pertaining to the availability of parking, location, pricing, service characteristics of the shuttle service, and questions on other access modes.

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Glossary

Airline passenger party	A group of people that travel together to an airport to take the same flight (the same is true upon the party's return).
Airport employees	Employees of the airport operator, airlines, other airport tenants, or other businesses located on the airport property.
Airport-operated public parking	The parking supply operated by the airport operator or a contracted parking operator on behalf of the airport operator. This parking supply is typically located on airport property.
Cell phone lots	Parking area for greeters to park and stay with their vehicles while waiting to pick up arriving airline passengers.
Connecting passengers	Airline passengers who arrive at and depart from the airport by aircraft as they connect between flights.
Economy parking	Parking supply intended to be the most economical option for airline passengers parking for the duration of their trips.
Employee parking supply	The parking supply at an airport that accommodates airport employees.
Functional capacity	The functional capacity of a parking facility is the point at which the parking supply becomes constrained. Functional capacity refers to the impracticality of managing a parking facility at 100% occupancy. It varies by airport, but generally ranges between 85% and 95% of supply.
Greeter	People who pick up an arriving airline passenger party at an airport. Greeters may pick up airline passengers at the curbside or use short-term parking.
Long-term or daily parking	Parking product intended to provide a convenient option for airline passengers parking for the duration of their trips.
Long-term parker	Airline passenger who parks a private automobile for the duration of his or her trip, regardless of which parking area is used.
Nonresident airline passengers	Airline passengers who are visiting the region in which the airport is located.
O&D passengers	Origin and destination (O&D) passengers board a flight at the airport to begin their airline travel or the local airport is the ending point of their airline travel.
Premium parking	Parking product intended to provide a higher level of customer service to a specific group of parking customers willing to pay a higher price for the convenience offered by the premium product.

Private automobile mode	Use of private automobile by airport employees or by airline passengers, greeters, or well-wishers picking up or dropping off airline passengers at the airport.
Privately operated parking	The parking supply that is privately operated and typically located off-airport. Often referred to in the Handbook as privately operated off-airport parking.
Public parking supply	The parking supply at an airport that serves airline passengers and the greeters and well-wishers of airline passengers.
Remote parking	Parking product located at a distance from the terminal building where walking between the parking area and the terminal building is prohibitive or otherwise not feasible.
Resident airline passengers	Airline passengers that reside in an airport's catchment area.
Short-term or hourly parking	Parking product intended to serve primarily short-term parkers (i.e., nonairline passengers such as greeters and well-wishers).
Short-term parker	Greeter or well-wisher who parks a private automobile to pick up or drop off airline passenger(s), regardless of which parking area is used.
Terminal area parking	Parking supply located adjacent to or within walking distance of the terminal building.
Valet parking	A premium parking product intended for long-term parkers who are interested in parking at a convenient location that does not require searching for a space.
Well-wisher	People who drop off a departing airline passenger party at an airport. Well-wishers may drop off airline passengers at the curbside or use short-term or hourly parking.

Acronyms

ALP	Airport layout plan
APDM	Airport Passenger Demand Model
APGS	Automated parking guidance system
APM	Automated people mover
ATR	Automatic traffic recorders
AVI	Automatic vehicle identification
BOS	Boston Logan International Airport
BUR	Bob Hope Airport
BWI	Baltimore/Washington International Thurgood Marshall Airport
CIP	Capital improvement program
CMH	Port Columbus International Airport
DCA	Reagan Washington National Airport
EDMS	Emissions and Dispersion Modeling System
FIDS	Flight information display system
HOV	High-occupancy vehicle
HSV	Huntsville International Airport
IAD	Washington Dulles International Airport
LAS	McCarran International Airport
LAX	Los Angeles International Airport
MDAD	Miami-Dade Aviation Department
MIA	Miami International Airport
MPO	Metropolitan planning organization
O&D	Origin and destination
O&M	Operations and maintenance
OAK	Oakland International Airport
ORD	Chicago O'Hare International Airport
PDX	Portland International Airport
SAN	San Diego International Airport
SEA	Seattle-Tacoma International Airport
SAT	San Antonio International Airport
SFO	San Francisco International Airport
TMA	Transportation management association
TPA	Tampa International Airport
TUL	Tulsa International Airport
VMT	Vehicle miles traveled

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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